1866804 - R8 SDMS

4 WATER QUALITY ASSESSMENT

4.1 Introduction

This Section includes an overview of stream classifications and standards and an assessment of available water quality data to determine if there are water quality and related watershed concerns. Water quality data are evaluated to determine if provisions of the Colorado Water Quality Control Act (CWQCA) are being met by the comparison of measured concentrations of chemicals to criteria set forth to protect the designated uses of a given water body.

There is an abundance of entities within the State of Colorado that gather water quality and quantity data as part of their resource management and/or investigative studies. As a first step to identifying those sources with relevant information, the CGS 'Directory of Colorado Water Quality Data' (CGS, 2003) was relied upon. As a result of researching a list of possible sources, it was determined that the information available for the *Project area* fell into the following categories;

- USGS – flow data.
- CGS – water quality, acid mine drainage (AMD) studies.
- Private or special interest group studies – biological and water quality studies.
- Industry/Consulting Groups – water quality and metal loading studies.
- Trustee/Agency studies to evaluate mine adit and mine waste loading within Silver Creek, St. Louis tunnel and others (USEPA, CDPHE).

Any available documentation or data summaries were summarized and discussed within this document. For certain sources, summaries that were directly described within their document were used for this plan (the data was not revisited and reevaluated herein; only the summary was relied upon). For others where data was not interpreted, the data was evaluated in detail within this document.

This Section first presents the applicable stream classifications and associated standards which are assigned to the *Project area*. These standards serve as the basis for understanding the implications of the water quality data. If the water quality data yields levels of contaminants at concentrations, greater than an applicable standard; then the water-body is said to have an 'impaired use'. If the water quality data are comparable, or less than the applicable standards, then the use is defined as being met. Therefore, in order to be able to draw conclusions about the water quality of the *Project area*, the first step is to research and identify the applicable standards. The second step is to obtain all available water quality information and then compare it to the standards. The second step is a formidable task in that it involves the research and identification of *Project area* studies that have acquired water quality information. These studies are often unavailable to the public, or perhaps a 'work in progress.' As such they have limited value and may be difficult to reproduce. Other studies may be old, or focused upon parameters or areas of little concern. These studies too, will have limited usefulness. It is important during this step to critique the available information and put it into perspective so as to not over or underestimate possible water quality conditions.

The results of this Section were used to identify data gaps that require further study, to determine sources of water quality concern and their trends over time and distance, and to formulate initial recommendations towards addressing the data gaps and water quality concerns. This Section begins with a review of the water quality standards pertinent to the *Project area* (subsection 4.2), a summary of the available water quality data sources (subsection 4.3), an evaluation/interpretation of the water quality findings (subsection 4.4), a review of watershed flow information (subsection 4.5) and a summary of recommendations (subsection 4.6).

4.2 Stream Classifications and Standards

In Colorado, the CWQCC and WQCD are responsible for regulating water quality through the establishment of water quality classifications, designations, standards, and control regulations to protect the beneficial uses of State waters including rivers, streams and lakes. In addition, the CWQCC and WQCD are responsible for the issuance of discharge permits, water quality certifications and enforcement actions. This subsection describes the classification and standards that pertain to the *Project area* as well as the regulatory background for their implementation. A copy of the most recent (DRAFT) CWQCC regulations that pertain to the *Project area* are provided in **Appendix D.**

4.2.1 Overview of Colorado's Classifications and Standards System

Federal Regulatory Overview

Increased awareness of and advocacy for environmental protection legislation took hold in the 1960s and 1970s. Federal law pertinent to surface- and groundwater quality protection has historically been piecemeal and focused at particular problems rather than the comprehensive protection of the resource. A more comprehensive approach to protecting surface and groundwater quality was enacted in the 1970s with passage of the CWA and Safe Drinking Water Act (SDWA). The state of Colorado manages and enforces these laws at the state level. In Colorado, the Colorado Department of Public Health and Environment (CDPHE) is the lead agency responsible for the administration, management, and enforcement of water quality regulations. A brief description of the CWA and SDWA as they pertain to the Upper Dolores watershed are described as follows;

- **CWA** – through the Environmental Protection Agency (USEPA) and state agencies, requires permitting of all point-source discharges through the National Pollutant Discharge Elimination System (NPDES) program authorized in Section 402 of the Act. Each NPDES permit incorporates numerical effluent limitations issued by the USEPA. Established limitations are applicable to different categories of industry (e.g. manufacturing, mining, etc.). In addition to these limitations, the USEPA has issued water quality criteria for over 115 pollutants including 65 named classes of toxic chemicals or 'priority pollutants'. Violations of the NPDES effluent limitations are punishable by up to a $25,000 per day fine. Other provisions of the DWA include the Section 404 program administered by the U.S. Army Corps of Engineers that requires a permit for the disposal of dredge and fill materials into waters of the U.S. and includes a provision for the protection of our nation's wetlands, and Section 319 of the Act with regulates nonpoint sources of pollution by management of surface runoff (Copeland, 1999).

- **SDWA** – provides national standards to protect the public from harmful effects of some contaminants in our drinking water. Colorado has accepted 'primacy' for this act and therefore accepts responsibility for enforcing these regulations (which are also under the jurisdiction of the CDPHE). The USEPA's National Primary Drinking Water Regulations set enforceable, health-based maximum contaminant levels (MCLs) for particular contaminants in drinking water. These MCLs are established by the USEPA after evaluating numerous toxicological tests and public comment. Secondary MCLs (SMCLs) are available for constituents where health risks are minimal, but certain levels can produce objectionable taste, odor, or appearance (e.g. iron staining, odor etc.). Chemicals or quality characteristics for which SMCLs exist include aluminum, chloride, color, copper, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, silver, sulfate, total dissolved solids and zinc (USEPA, 1999).

There are other pertinent federal regulations that influence the use and quality of waters that do not currently have a considerable impact to the Upper Dolores. For instance, the 'Wild and Scenic Rivers Act' is a federal program that attempts to preserve the aesthetics and existing uses of significant stream resources by prohibiting water development near the designated segment. Currently, only the Cache Le Poudre River has such a designation, however, other segments such as the Dolores may be proposed (NPS, 2006; Vranesh, 1989)

State Regulatory Overview – Surface Water and Groundwater

In Colorado, the Colorado Water Quality Control Commission and WQCD are responsible for regulating water quality through the establishment of water quality classifications, designations, standards, and control regulations to protect the beneficial uses of State waters including rivers, streams and lakes. In addition, the Commission and WQCD are responsible for the issuance of discharge permits, water quality certifications, and enforcement actions.

The system of assigning surface water and groundwater classifications and standards is administered by the CWQCC and WQCD. Water quality standards set the goals, pollution limits and protection requirements for each water-body and each chemical of concern. Identification of suitable standards for a water-body is based on adopting use classifications that identify those uses to be protected on a stream segment and then adopting numerical standards for specific pollutants to protect those uses.

Use classifications and numeric water quality standards have been adopted for streams, lakes, and reservoirs throughout each of the State's river basins. Within each basin, waters are divided into individual stream segments for classification and standard setting purposes. Water quality standards are applied in a regulatory context principally through the Colorado Discharge Permit System (CDPS) where point source dischargers are regulated to ensure that water quality standards are met.

Site-specific water quality classifications are intended to protect existing uses of State waters, and any additional uses for which waters are suitable or are intended to become suitable. The current use classification categories are:

- Recreation (Class 1a, 1b, or 2);
- Agriculture;
- Aquatic life (Cold or warm water, Class 1 or 2);
- Water supply (potable supply); and,
- Wetlands.

The CWA requires that water-bodies attain or maintain the water quality needed to support designated and existing uses. For each classified stream segment, numeric water quality standards are adopted that are intended to maintain water quality at a level sufficient to protect the classified uses. There are three potential approaches to the adoption of site-specific numeric standards. First, table value standards (TVS) are based on criteria set forth in three tables contained in the Commission's Basic Standards and Methodologies for Surface Waters (3.1.0 5 CCR1002-8). These are levels of pollutants determined to be generally protective of the corresponding use classifications, and are applied in most circumstances, unless site-specific information indicates that one of the following approaches is more appropriate. Second, ambient quality-based standards (i.e. standards based on the existing instream quality) may be adopted where natural or irreversible pollutant levels are higher than would be allowed by table value standards, but are determined adequate to protect classified uses. The third option is to adopt site specific standards where a bioassay or other site-specific analysis indicates that alternative numeric standards are appropriate for protection of classified uses.

Most domestic-water-supply standards are based on 'total recoverable' metals (unfiltered), and most aquatic-life standards are based on hardness of the water and dissolved ion concentrations (filtered). Important exceptions to this generalization include iron and manganese. Both of these metals have aquatic-life standards of 1,000 ug/L (total recoverable). The much lower dissolved concentrations (300 ug/L for iron; 50 ug/L for manganese) are standards for aesthetic purposes in drinking water.

The quality of Colorado surface waters is reviewed every 2 years by the CWQCD, in compliance with the CWA. Placement on the list of stream segments that are not in compliance with standards (called "303(d) lists") has significant implications for management of those waters (CDOHE, 2002 and 2006). The Nonpoint Assessment Report (CDPHE, 1989) contains more than 180 pages of technical information and lists stream segments that were considered impacted by mining, agricultural or industrial activities; and is referenced in **Section 7** of this report.

Outstanding and Use-Protected Waters

In addition to water quality classifications and standards, either of two water quality based designations may be adopted in appropriate circumstances. An "Outstanding Waters" designation may be applied to certain high quality waters that constitute an outstanding natural resource. No degradation of outstanding waters by regulated activities is allows. A "Use-Protected" designation may be applied to waters with existing quality that is not better than necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water. The quality of these waters may be altered so long as applicable water quality classifications and standards are met. Waters that are not given one of these designations are subject to the State's Antidegradation Review requirements before any new or increased permitted water quality impacts are allows.

Antidegradation Review

The activities that are subject to antidegradation review requirements are those that:

- Require a discharge permit
- Require water quality certification under Section 401 of the CWA
- Are subject to control regulations (WQCC, 1998)

The first step in the antidegradation review process is a determination, in accordance with criteria specified in the regulation, or whether 'significant degradation' would result, a determination is made of whether the degradation is necessary to accommodate important economic or social development in the area in which the waters are located. The determination is based on an assessment of whether there are water quality control alternatives available that would result in less degradation of State waters and which are economically, environmentally, and technologically reasonable. The proposed degradation is allowed only if no such alternatives are available (WQCC, 1998).

303(d) List

Section 303(d) of the Clean Water Act requires each state to identify waters for which technology-based effluent limitations and other required controls are not adequate to attain water quality standards. Those stream segments of water bodies require Total Maximum Daily Load (TMDL) allocations in order for the segment to attain or maintain water quality standards. A TMDL is the estimated assimilative capacity of a water-body, which indicates how much of a pollutant may enter a water-body without impairing its designated uses. The TMDL represents the sum of the point sources, the nonpoint sources, and a margin of safety (which can include anticipated future pollutant loading). The current 303(d) List is presented in the Status of Water Quality in Colorado 2000 (the State's 2000 305(b) Report (CDPHE WQCD, 2000) and the 'Water Quality Limited Segments Still Requiring TMDLs document (CDPHE, 2002). Subsection 4.2.2 describes the 303(d) listed areas that pertain to the *Project area.*

Groundwater

Groundwater quality in the State of Colorado is addressed in the Colorado Water Quality Control Act (CWQCA). The Colorado Water Quality Control Commission and Water Quality Control Division, both a part of the CDPHE, administer this act. The basic standards for groundwater are found in the Colorado Code of Regulations, 5 CCR 1002-41. The key narrative standard is that "groundwater shall be free of pollutants" that may be toxic to human beings or a danger to the public health and safety (CGS, 2003). To administer the policies and rules pertaining to water quality management, the CWQCC has established the following groundwater classification system:

Domestic Use Quality
- Meet human health Standards (as shown in **Table 4.1**).
- Total Dissolved Solids (TDS) < 10,000 mg/L

Agricultural Use Quality
- Meet Agricultural Standards (as shown in **Table 4.1**).
- TDS < 10,000 mg/L

Surface Water Quality Protection
- If proposed or existing activity will impact groundwaters such that water quality standards of classified surface water bodies will be exceeded.

Potentially Usable Quality
- TDS < 10,000 mg/L
- Not currently used for domestic or agricultural, but the potential exists in the future

Limited Use and Quality
- TDS > 10,000 mg/L
- Does not meet the criteria of other classifications

The WQCC has also adopted site-specific standards for 49 well-field areas within the state (5 CCR 1002-42).

4.2.2 Dolores River Basin Classifications and Standards

The Basic Standards and Classifications, including the basis and purpose of the standards and classifications can be found in CDPHE WQCD, 2002, . Water quality standards for stream segments within the *Project area* are presented in **Tables 4.2 through 4.5. Table 4.2** (pages 1 through 3) provides the water quality standards applicable to the *Project area* by segment. There are new revisions as per the recent CWQCC triennial hearing (refer to **Appendix D**). **Table 4.3** provides the specific equations (or TVS – Table Value Standards) referred to in **Table 4.2**. These first two tables provide the standards protective of aquatic life, with some potable supply values integrated within them. **Table 4.1** provided the remaining standards applicable to 'agricultural' and 'potable or domestic' supply specifically (that are not already presented in **Tables 4.2 and 4.3**). Currently, there are certain numeric standards being revised for the segments associated with the *Project area* (CDPHE, CWQCC, 2006). A summary of changes that will become effective by December, 2006 is provided in **Table 4.4** (current standards documents are provided on CDPHE, 2006 http;//www.cdphe.state.co.us/op/regs/waterqualityregs.asp) and within **Appendix D**. These adjustments have been accounted for in the water quality data analysis presented in later subsections of this Section.

Streams within the *Project area* are classified for protection of cold water aquatic life (Class 1), recreation (Class 1 and 2), water supply and agricultural uses. The following segment is designated as 'Outstanding Waters', and thus, does not allow degradation of water quality:

> *Dolores River Segment 1: All tributaries to the Dolores River and West Dolores River, including all wetlands, tributaries, lakes, and reservoirs, which are within the Lizard Head Wilderness area.*

The above segment pertains to waters specifically associated with the Wilderness area and does not encompass the entire *Project area*. The remaining *Project area* segments are encompassed by the following segment designations by the WQCD:

> *Dolores River Segment 2: Mainstem of the Dolores River from the source to a point immediately above the confluence with Horse Creek.*

> *Dolores River Segment 3: Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek.*

> *Dolores River Segment 8. Mainstem of Horse Creek from the source to the confluence with the Dolores River.*

> *Dolores River Segment 9. Mainstem of Silver Creek from a point immediately below the Town of Rico's water supply diversion to the confluence with the Dolores River.*

There are no "Use-Protected" segments which indicate all waters within the *Project area* are subject to the State's antidegradation review as it is applied to discharge permit holders and 401 certification.

There are portions of the *Project area* that have been listed for impairment for one or more parameters on Colorado's 2002 303(d) list. Stream segments proposed for listing via the 2004 303(d) list and the accompanying Monitoring and Evaluation list (a list of sites for water bodies in which information suggests impairment, but supporting documentation does not meet the standards for credible evidence (CDPHE, 2002)) are described in Colorado WQCC regulations 93 and 94 (CDPHE, 2002; 2004). The state's 2004 proposed 303(d) list includes portions of Silver Creek (for cadmium, and zinc) as well as McPhee and Narraguinnep Reservoirs (mercury) (CDPHE CWQCC, 2004; CWCB, 2004). The TMDL status of these segments has adjusted over time. For instance, there was currently a temporary modification for zinc (refer to **Table 4.4**) for upper Silver Creek. This modification was reviewed and amended as per findings from the CWQCC Rulemaking Hearing (June 12, 2006; CDPHE CWQCC, 2006). It will be documented within the CWQCD Standards documents by December, 2006. In addition, based upon review of information, the State (in accordance with USEPA approval) removed manganese as a parameter of concern for the *Project area* segments. Also, Phase I TMDL efforts have been completed for the segment associated with McPhee Reservoir (CDPHE, 2006).

Specific information pertaining to the TMDL designations related to these areas is presented in **Table 4.5**. This information dictates that these stream segments require a TMDL, and the State must quantify the pollutant sources and allocate allowable loads to the contributing sources, both point and nonpoint, so that water quality standards can be attained for that segment. This process involves five basic steps:

1. Select the pollutant to consider (i.e. Cd and Zn),
2. Estimate the water body assimilative capacity (not completed – can be achieved by a loading/water quality analysis- refer to **Section 8)**
3. Identify the contribution of that pollutant from all significant sources (not completed – can be achieved by a loading/water quality analysis- refer to **Section 8)**
4. Analyze information to determine the total allowable pollutant load (not completed – can be achieved by a loading/water quality and ecological risk analysis- refer to **Section 8**),
5. Allocate (with a margin of safety), the allowable pollution among the sources so that water quality standards can be achieved (not completed – can be achieved by a loading analysis and ecological risk analysis- refer to **Section 8**).

Implementation of the TMDL is the final step. It requires participation from all the stake holders as TMDL's are not self implementing. The Waste Load Allocation portion of the TMDL can be implemented through effluent limits in discharge permits. In the case of nonpoint sources, voluntary controls or locally enacted controls are necessary to implement the Load Allocations. The State relies on the authority already granted by the CWA to implement TMDLs.

The State representative (Aimee Konowal/CDPHE) has communicated with the author of this document in regards to collaboration with the Town of Rico and others, for the TMDL development. This document will assist in a 'data gaps' analysis for the TMDL effort and is being completed concurrent with this document. It is important that the Town take an active role and participate in this process so as to keep on top of the regulatory process and its implication to the Town setting.

4.3 Water Quality Data

This Section outlines water quality data available in the *Project area*. To date, a comprehensive watershed-scale or basin-wide water quality database and geographic information system (GIS) are not available. A thorough review of available sources was completed (i.e. review of all listed sources as provided by CGS, 2003). The primary sources of water quality data for the project were derived from independent sources who were researching different facets of the system. These sources include;

- CDPHE and USEPA historic studies of mining district areas within and around the Town of Rico (CDPHE, dates; USEPA, dates[most are compiled within USEPA's STORET Data Warehouse (USEPA, 2006 a through 2006c)
- SEH datasets – generated as part of the St. Louis Tunnel monitoring program.
- Water quality data from USEPA's STORET database
- USGS Flow Data and some water quality data,
- CGS data and studies (CGS, 2000; Neubert, 2000)

The information gained from these various entities needs to be scrutinized closely. The purpose for the collection of each piece of information is distinct and can be taken out of context if not thoroughly understood and put into perspective. For instance, various studies served the purpose of characterizing 'worst case' conditions of known contaminant releases. These results therefore provide only a snap shot of water quality conditions within a very confined spatial and temporal timeframe. Where possible, the uncertainties associated with the interpretation of these various data packages were taken into account. As a result, the interpretation has caveats that describe the extent of certainty associated with a drawn conclusion.

4.3.1 Introduction

A number of sources of water quality information for the *Project area* are available. Most were designed to answer a specific question and do not provide a 'basin wide' perspective of the water quality condition. The report used all available validated data in order to construct as-best-as-possible, a basin-wide review of the water quality conditions. Numerous studies as previously mentioned had a focused purpose and thus a limited usefulness to this report. Summaries of the data obtained from these previous studies are provided below.

4.3.2 Historic Evaluations

The historic mining district and its associated features of adits, waste piles etc. have often been the focus of various water quality investigations. Some 'baseline' work has been completed by others that attempt to characterize the watershed as a whole. While yet others have completed studies to describe unique setting characteristics such as residential soils, geothermal water quality etc. This project relied on all of these pieces of information in order to try to characterize the watershed as a whole, over time. Of course, given such a heterogeneous data set there ends up being gaps in the information and the whole story can not be told. As a result, a 'data gaps' analysis was completed in order to identify the critical pieces of information that need to be gathered before a comprehensive characterization can be completed.

A chronology of the events that have taken place that have lead to the various types of studies was previously documented by the Matrix Design Group (2004) and is summarized herein. Additional studies beyond those described by Matrix were located as a part of this effort. They were integrated into the following chronology where appropriate.

Figure 4.1 depicts the timeline and chronology of studies completed in the Rico area and their associated purpose. As shown in this figure, there was an era focused upon the soils and sediment conditions and the mining impacts to these media (and possible risks to human health and the environment). There were a number of 'site investigation efforts associated with the USEPA evaluation of the area (USEPA, 1994). The information from these previous investigations is of some use, but has the limitation of being historic and of questionable use given the focus of these investigations. There has long been an interest in water quality in the area, but a surge of activity was noted in the 1990s likely in response to the following events:

- The St. Louis Ponds were the site of lime neutralization and gravity sedimentation during mining operations. These were the preferred techniques for the treatment of the acid mine drainage; however, the neutralization process was discontinued and the plant dismantled after the sale of the property to Rico Renaissance during the 1990s. The history of the St. Louis tunnel and a water treatment plant at the site is complex. The information presented in the following is summarized from file records kept by the Town of Rico. There may be some 'gaps' in the information, therefore the following information has some uncertainty associated with it. Atlantic Richfield Corporation (AR), now a subsidiary of British Petroleum, bought mines from Rico Argentine containing the world's second largest known deposit of molybdenum (the largest is in Crested Butte). Molybdenum is used mixed with metal alloys to harden steel. AR determined, however, that it was not feasible to mine and turned around and sold everything to Rico Development Corporation in 1980. That sale also passed on to RDC the obligation of maintaining the water treatment plant at the St. Louis tunnel subject to a national pollution discharge elimination permit (NPDES). RDC ran the water treatment plant from 1988 to 1994, when they entered into negotiations to sell all their holdings to Rico Renaissance a development company. Rico Renaissance did not however, buy any liability properties, including the water treatment plant. After RDC received payment from Rico Renaissance, they 'walked away' from Rico and allowed the corporation to lapse. In November 1996, the state dissolved the corporation. The Colorado Department of Justice filed a suit against RDC in 1999. When AR realized RDC wasn't going to reassume responsibility, they stepped in to pay Colorado for a water quality assessment and began a voluntary approach to clean up the river. (L.Lance, 2003). A brief regulatory history in regards to the St. Louis Tunnel and associated ponds is as follows;

- In 1980, the CDPHE WQCD issued a Notice of Violation NOV) and a Cease and Desist Order (CDO) because of problems in meeting compliance limitations (USEPA, 1984).
- The NOV and CDO were amended on December 17, 1981 and specified exceedances of zinc and copper standards. This led to the development of a water treatment system using slaked lime at the St. Louis Tunnel Adit (WMD, 1994).
- A NOV was issued by CDPHE for cadmium permit standard violations in November and December, 1984 (USEPA WMD, 1994).
- A NOV and CDO were issued in 1990 for violations of lead and silver standards. Un permitted discharge from the Blaine Tunnel on Silver Creek was also reported in 1990, which resulted in construction of a concrete dam by RDC to plug the Blaine Tunnel (USEPA WMD, 1994).
- A NOV was filed in 1993 for silver violations (USEPA WMD, 1994)

- In the mid-1990's the Atlantic Richfield Company (AR) enlisted in the Colorado Voluntary Cleanup and Redevelopment Act (VCUP) in order to address sites with remediation needs. By addressing these sites through the VCUP program, they would be remedied without receiving a 'Super Fund' designation by the USEPA. The process involved the assessment of several sites within the Silver Creek and Dolores River drainages including the Argentine Tails, Columbia Tails, Grandview Smelter, Santa Cruz and Silver Swan mine sites. An evaluation of the contaminants associated with these sites was completed by AR (and previously by others; i.e. USEPA, 1994. Upon review of site contaminant conditions, AR developed a variety of remedy strategies that would be appropriate for the curtailment of contaminant concerns. Certain sites were found to pose little to no risk concern and were therefore recommended for a 'no action determination' (NAD), while others required remedy efforts (ESA Consultants Inc., 1999). A summary of the NAD and VCUP sites addressed by AR is provided in **Table 4.6.**The verification of the effectiveness of the remedies was completed by conducting water sampling above, within and below the site areas. A series of reports documenting the VCUP actions, surface water monitoring activities and maintenance efforts are on file within the Town of Rico records (refer to the ESA Consultants Inc., 1999 report for a comprehensive listing).

- In 1999 CGS conducted a reconnaissance level investigation of NOAMS areas which included the Horse Creek tributary of the *Project area*. It was determined that the geothermal and natural mineralization characteristics to the area have leant to measured elevated metals concentrations in Horse Creek. This information is useful to understand the potential range of metals concentrations that can occur as 'background' to the *Project area* (Neubert, 2000).

- In 2001, the WQCD of CDPHE performed a water quality assessment at the request of AR, to assess potential permit limits for the Rico-Argentine mine drainage. The assessment collected new data and compiled previously collected surface water data from locations within the *Project area*. The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern. The results were also quantified in terms of 'load' to determine which point sources were of most concern (**Table 4.7**). These results were contested by AR. As a result, AR continues to sample and analyze metals content in surface water settings at distinct points in the area. The sampling is completed by SEH Consultants and continues to this day. **[As per information provided by AR upon review of this document: "This assessment was a draft document containing numerous assumptions given the significant data gaps at that time. Since release of the 2001 draft, substantial additional data and related analysis have filled many of those data gaps. These analysis indicate that discharges other than the St. Louis Ponds are not directly relevant to the Water Quality Analysis (refer to SEH, no date) for the Dolores River at the St. Louis Ponds that that the river water quality will be protected by the anticipated discharge permit limits at the St. Louis Ponds.]**

- CDPHE and the Town of Rico became interested in the possibility of property redevelopment opportunities that can be provided through the Brownfield's program. The Brownfield's program is a state and federal program that facilitates the redevelopment of former industrial areas that has limited or no redevelopment due to environmental concerns. There were two areas (the Street Maintenance Garage and the St. Louis Tunnel Area) that were felt to fall within the potential Brownfield's arena. As a result, a soils and groundwater studies were completed in order to identify constituents of concern.

The types of studies completed fall into three investigation-type categories of soil, sediment and water (refer to **Figure 4.1**). The soils and sediment studies involved the characterization of lead in soils and sediments from the former mining operations. The water studies were also typically related to the mining operations. The water studies specifically served various objectives including the characterization of the acid mine drainage neutralization process within the St. Louis settling ponds, water quality issues related to the capped tailings along the Dolores River and Silver Creek. These studies were completed by USEPA, CDPHE, AR and others and are summarized as follows;

> ***USGS*** has completed sporadic surface and groundwater investigations within the *Project area*. **Table 4.8** provides a summary of the types of data gathered by location. This information was gathered as a part of the USGS routine monitoring programs completed at their gauging station and monitoring well locations (summary of Dolores county information provided on USGS, 2006a and b). For Dolores County, the USGS has historically had 29 water quality sampling locations, six of which occur within the *Project area*. Similarly, there were 25 groundwater locations within Dolores County, three of which occur within the *Project area*. Summary information describing these sampling locations (relevant to the *Project area*) are provided in **Table 4.8**. The samples collected serve the purpose of characterizing a site setting as a whole, and were not biased towards characterization of an impacted area or other. However, the suite of variables analyzed for were extremely limited. The most robust type of data gathered was 'flow' as measured at the gauging station located below the Town. Sampling at the USGS locations has been discontinued. The only ongoing USGS investigations involve the collection of flow data from the gauging station 09165000 (Dolores River, below Rico).
>
> ***USEPA*** has performed investigations beginning in 1984 through to 2003. In 1984 the USEPA collected surface water and sediment associated with the Argentine Mine adjacent to Silver Creek. Results indicated that sediment was contaminated downstream of the tailings and settling ponds, however, only manganese occurred at elevated levels in surface water (downstream of the tailings and settling ponds) (Ecology and Environment, 1985).
> In 1986 the USEPA completed a soil and sediment study throughout the Town of Rico. Results indicated elevated lead levels occur throughout the area. No other information regarding other metals was summarized. In 1994, Prior to VCUP activities, an inventory of sources of mine-related contamination and their source areas were completed by the USEPA (USEPA, 1994). Since that inventory, numerous activities including the removal of residential soils and VCUP actions on several mine-waste sources have been completed. At the time of the USEPA, 1994 historic site investigation, an estimated 75 acres of tailings piles and settling ponds occurred along both the Dolores River and Silver Creek, with an unknown amount of tailings moved into town as street cover. The source areas were estimated to contain 400,000 tons of material. In 2003, the USEPA evaluated if mine waste material was impacting the Dolores River, Silver Creek, and ground-water potable supply aquifer areas. A human health risk evaluation was completed. Results indicated that lead occurs at elevated levels in the Dolores River corridor and in certain neighborhoods near the historic smelters. As a result of the studies findings, AR submitted a voluntary cleanup up (VCUP) for soils investigation, remediation and restoration throughout the town of Rico.

The USEPA also maintains a comprehensive water, sediment, biological and habitat database (STORET) that is linked to a GIS mapping system (EnvirroMapper). These databases contain some, but not all of the records described herein.

The **U.S. Department of Interior, Bureau of Reclamation** conducted surface water and sediment sampling in the Dolores River and its tributaries between 1989 and 1993. The results showed Silver Creek to be a major, but not the only, source of mercury and other heavy metals in the upper Dolores River Basin. This report was not locatable during this effort and only summarized references were obtained (Bureau of Reclamation, no date; as referenced in URS/USEPA, 1996).

An 'Analytical Results Report' of the Rico-Argentine site was prepared **by URS Operating Services in coordination with the USEPA Superfund Technical Assessment and Response Team.** The report summarizes the field work and analytical findings from a site investigation effort completed from September 11 through the 15, 1995 and encompassed surface water, sediment, residential soil and groundwater sampling. Samples were collected within the Rico Argentine mine site, and additional characterization measures (i.e. flow) were captured from non-site areas (such as Scotch Creek, etc.) Results indicated:

- Surface water had elevated levels of metals in locations associated with tailings.

- Sediment from the settling ponds had elevated levels of some metals, in particular, calcium demonstrated an elevated trend.

- Groundwater did not contain any organic compounds, but had detectable concentrations of barium, calcium, magnesium, manganese, potassium, sodium and zinc. These detections however did not indicate that contamination had occurred from the Rico-Argentine site.

Water quality characteristics of the geothermal springs has been studied by others. Water quality measured in 1995 indicates that the two springs have a common source **(Table 4.9)**. Water flowing from these springs is depositing calcium carbonate and iron about the springs and there are visible geothermal deposits between the springs and the town of Rico (URS 1995a; URS 1995c) Previous studies also indicates that there are elevated levels of arsenic within these springs as well (E.Heil, no date).

In 1998, the **CGS** summarized their findings from a comprehensive evaluation of abandoned mine features (adits, waste or tailing piles, etc.) associated with federal lands. The CGS completed site investigations of 'hazards' associated with each feature by reviewing the history, setting, exposure conditions to human and ecological receptors and the potential contaminant concentrations. As a result of the culmination of these findings, the CGS would rank each feature within a site using 'Environmental Degradation Ratings (EDRs) of extreme, significant, potentially significant, slight, or none; and sites with Physical Hazard Ratings (PHRs) of extreme danger, or dangerous. Private (patented) land in-holdings, were found to often contain the largest mines and were only investigated when evidence indicated that environmental degradation emanating from these sites affected USFS-managed lands. All the features associated with a site were evaluated.

The sites associated with the *Project area* that were addressed by CGS, their features and associated EDR rankings are summarized in **Table 4.10. Figure 4.2** demonstrate the location of each Site within the *Project area*. The ranking was based upon the EDR and PHR feature values associated with each Site. The Sites were compared to each other, and ranked. Those Sites elevated (ranked with the lowest numbers) represent the Sites requiring the most immediate attention in order to control contamination issues and/or physical hazards. Only those Sites associated with the *Project area* are listed. There are other Sites within other watersheds which were ranked within this CGS report but are not important to this evaluation. The definitions for the EDR and PHR values are as follows;

EDR Value Definitions
1) Extreme
2) Significant
3) Potentially Significant
4) Slight
5) None

PHR Value Definitions
1) Extreme Danger
2) Dangerous

Results of the CGS findings indicate that there are a number of mine sites with mixed ownership (both private and federal) that create environmental hazards and require further attention. This may mean that further study is required, or that a potential remedy is essential in order to control the hazards created by the feature. These Sites are further described and evaluated within **Sections 7 and 8** of this report.

The **US Department of Interior, Bureau of Reclamation (BOR)** conducted a Dolores river basin study of mercury to determine the source of mercury in fish tissue samples. A summary of findings was located within the USEPA, 1994 report, but an original copy of the BOR report could not be located, therefore there is uncertainty with the following information. For the BOR effort, Fish tissues samples were collected from September 1989 through March 1991, at the McPhee and Narranguinnep Reservoirs. Tissue results were found to contain high levels of mercury (E&E, 1991a and 1991b as cited in USEPA, 1994). In turn, the BOR began surface water and sediment sampling in 1989 along the upstream reaches of the Dolores River and its tributaries to determine potential sources of the mercury. The sampling continued periodically every year through 1993. The sediment data show Silver Creek to be the major source of heavy metals, including mercury in the upper Dolores River basin. The April 1992 water samples indicate that, in addition to Silver Creek there are numerous sources of mercury in the upper Dolores River basin and many of them are located well downstream from Silver Creek. The study also shows metal loading from various mine drainages which contribute to contamination of the Dolores River (BOR, 1994 as cited in USEPA, 1994.

Walsh Environmental completed Phase I and II Environmental Site assessments for Rico Renaissance on approximately 3,000 acres of land in and around Rico in 1995. A limited number of soils and surface water samples were taken. Results indicated that there are elevated lead levels primarily related to former mining operations. Walsh categorized different types of areas where waste rock and tailings were evident. Results of the metals analysis as compared to these categories of areas indicated that areas with mine tailings, slag or spoils in surface or subsurface soils, had elevated concentrations of metals. In addition to the sampling efforts, Walsh characterized several potential nonpoint sources of pollution associated with distinct properties. These included septic tanks and a leach line at an Assay Building, a leaking UST and other wastes associated with various buildings. The most relevant information gathered from these studies includes the samples of soil and surface water which are described in further detail in **Appendix E** to this report. The results from these analysis were not integrated into the water quality dataset evaluated within this report, but rather, provide supporting lines of evidence for the overall evaluation of the site setting.

As part of the AR VCUP/NAD program, ***AR*** has submitted approximately thirteen VCUP or No Action Determination (NAD) applications to manage tailings piles and slag piles in around the town of Rico (from 1995 to present). **Table 4.6 previously** summarized the VCUP or NAD application and the status of the request. Under the VCUP program, AR has removed and/or stabilized, or capped mine tailings that had previously been located in or adjacent to Silver Creek and the Dolores River. The former tailing piles were re-contoured and capped to limit the amount of surface water infiltration.

In 1996 ***Titan*** conducted a geological and geochemical mapping of the soils in Rico to characterize metals concentrations in relation to the mineralogy of the source material and historic mining and processing operations. Results indicated that concentrations of certain metals (including lead) in surficial deposits are derived predominantly from geologic processes acting on natural sources.

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Data From ARCO – to request

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Also in 1996, CDPHE and AR conducted a soils study in Rico in order to document the sources of lead found in residential soils. Results include:

- Natural sources of elevated lead levels are present in and around Rico. The exposure and weathering are the cause of naturally occurring lead in the soils near surface mineral bearing ore bodies.

- Man-made sources with elevated lead concentrations are present in the area. The sources include mine waste rock, mill tailings, and smelter slag.

- Long term impacts on soil properties as a result of the acid plant operation appear to be minimal.

- Efforts to identify smelter products were inconclusive and more study is required to assess historic smelter impacts.

Kathleen S. Paser performed an analysis of treatment alternatives for the St. Louis tunnel discharge in 1996 as part of her Master's requirements for the Colorado School of Mines, Chemical Engineering and Petroleum Refining program (Paser, 1996). Ms. Paser evaluated the (then) current technologies that may suitably treat the St. Louis acid mine discharge. Her findings indicated;

- There is approximately 40% loss of water through the pond system due to loss through recharge to the subsurface.
- There is only marginal success using this treatment technology for the removal of CDPHE permitted metals (cadmium, copper, lead, silver, and zinc).
- 98% of the solids in the treated drainage settle in the upper ponds closest to the mine and the solids primarily settled are iron and calcium.
- The upper ponds are at 75% of their designed capacity due to the buildup of sediment resulting channelized flow. This has caused a 74% reduction in the residence time in the upper ponds needed to facilitate sedimentation and a spillover of solids into the lower ponds.

Recommendations from Ms. Paser's report include;

- Dredging of the upper ponds as a short-term extension of the existing treatment system while other alternatives are evaluated.
- Possible alternative technologies include: Lime neutralization with sludge recycling, biogenic H_2S sulfide precipitation using municipal sewage as an electron donor, and constructed wetlands.

In 1999, ***CGS*** conducted a reconnaissance-level investigation of naturally degraded surface waters associated with hydrothermal alteration in Colorado. Many of the study areas were previously identified as having 'natural' degraded surface water quality as a result of an abandoned mine inventory conducted by the CGS and the USFS from 1991 to 1998 (Sares, 1996) During the 1999 study, filtered and unfiltered water samples were taken from areas with naturally degraded conditions. The Horse Creek tributary to the *Project area* was investigated as part of this study. 'Ferruginous springs' (iron enriched) were reported in the northern and western branches of upper Horse Creek and in lower Horse Creek. These springs have deposited limonite in swampy areas of the stream valley. Although mines are present in these basins, limonite deposits were recorded as early as 1900 (Harrer and Tesch, 1959). The limonite deposits are probably not a result of upstream mines. The CGS found three locations within the Horse Creek sub-basin (referred to as locations NW-80, NW-81 and NW-82). Results are summarized by location as follows;

- Sample NW-80 was near the headwaters of Horse Creek. Flow was 150 gpm, pH was 7.86, and conductivity was 198 uS/cm. Despite the weakly altered rock above the site, the CGS found this water to be relatively clean and did not exceed standards in any of the tested parameters **(Table 4.11)**.

- Sample NW-81 was from one of several springs emerging in and adjacent to a natural iron bog on the south side of Horse Creek. Flow was estimated at 100 gpm for the series of springs. At the sample site, pH was 4.18 and conductivity was 298 uS.cm. Manganese, aluminum and copper significantly exceeded standards; and zinc, cadmium, and iron also slightly exceeded standards **(Table 4.11)**.

- Sample NW-82 was collected from a seep along a steep gulch that borders the east side of the iron bog. This area was mapped as a landslide deposit and had altered rocks which were bleached, chalky and crumbly. Flow was 23 gpm, pH was 7.12 and conductivity was 449 uS.cm. Hardness was high with a level of 449 mg/L. Manganese concentration was 50 times higher than the state standard. Sulfate was elevated, but within standards. Zinc and cadmium were also elevated, but within their hardness-related standards **(Table 4.11)**. The CGS noted that this located formed precipitates, and the results indicate that aluminum and iron occur as suspended solids (Neubert, 2000).

In 2001, ***CDPHE WQCD*** performed a water quality assessment at the request of AR, to assess potential permit limits for the Rico-Argentine mine drainage. The assessment collected new data and compiled previously collected surface water data from locations within the *Project area*. The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern. These results were contested by AR. **Table 4.7** presented the loading estimates provided by CDPHE for the seven point-source discharges The findings of the assessment indicate that the combined point source discharge contributions exceed the stream's assimilative capacity (of 4.95 lbs/day) by 31.6 lbs/day. The sampling was performed during low flow conditions of the Silver Creek and Dolores River, and indicated that the capping performed by AR on the various former tailings piles has not eliminated the leaching from these former tailings piles and is still contributing metals loading under low flow conditions. AR has disagreed with the CDPHE findings and no permit application has been submitted for the adit discharge to date. The data collected by CDPHE was integrated into SEH's comprehensive data set.

The ***United States Fish and Wildlife Service (USFWS)*** reviewed the CDPHE water quality assessment and prepared a memorandum to address their own concerns regarding the metals concentrations in Silver Creek and the Dolores River in and near the Town of Rico. The memorandum documented their recommendation to study the contaminated sediment that may have accumulated over time and potentially be causing harm to exposed aquatic life. They recommended further collection of water and sediment from collection areas such as wetlands and depositional habitats.

In 2002, **Short Elliott Hendrickson Inc. (SEH Inc.).** began a water quality/loading evaluation of locations within the Upper Dolores drainage, Silver Creek and focused locations associated with the St. Louis tunnel. As part of their efforts, they compiled available existing information from historic studies that gathered water quality information for the same, and other similar locations. A fairly cohesive dataset was established and lent to Grayling Env. for the completion of this report. Several of the datasets described within this subsection were integrated into the SEH dataset for comparison purposes only. A summary of the types of samples analysis completed by location that occur within the SEH dataset are provided in **Table 4.12 and Table 4.13**. SEH has produced documents describing the results of their water quality and loading measurements for 2002 (SEH, 2002a and 2002b). Reports for the follow-on years are pending.

In 2003, ***CDPHE*** conducted a Phase I Brownfield's Assessment of two potential redevelopment sites in Rico: the Street Maintenance Garage area located within the Town of Rico, and the St. Louis Tunnel Area. The findings of the assessment did not identify elevated levels of any specific constituent; however the maintenance garage site is also the location of the former power plant which is a potential source of polychlorinated biphenyls (PCBs) and no assessment of PCBs was completed as part of this effort. The St. Louis ponds area (north of the actual ponds) was evaluated, yet no constituents of concern were identified in this area.

CFAR, 2005 "Monitoring of the upper Dolores River" was begun in 2002 by a local citizen's group (CFAR) in response to concerns about the impact of increasing development on the Dolores River Valley. Results on biological toxicity assessment (using aquatic snails) and water quality testing up to the end of 2003 are summarized in the 2005 document. Further data are forthcoming in capacity (of 4.95 lbs/day) by 31.6 lbs/day. The sampling was performed during low flow conditions of the Silver Creek and Dolores River, and indicated that the capping performed by AR on the various former tailings piles has not eliminated the leaching from these former tailings piles and is still contributing metals loading under low flow conditions. AR has disagreed with the CDPHE findings and no permit application has been submitted for the adit discharge to date. The data collected by CDPHE was integrated into SEH's comprehensive data set.

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Report From
SEH - consultants
Short Elliott Hendrickson
WQ data

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URS, 2006 documents the analytical results of the Rico argentine Upper Dolores Watershed study which served the purpose of gathering information for the evaluation of the Dolores River watershed with regard to the aquatic ecosystem and fishery. Samples of surface water, phytoplankton, zooplankton, macroinvertebrates, fish tissue and ultra-clean surface water and sediment samples for mercury and methyl mercury analysis. Study objectives included the estimation of mercury loading from the Silver Creek, Bear Creek and West Dolores River mining districts, as well as determination of mercury concentrations associated with a high flow (summer rain event) condition. Results from the efforts are as follows;

- The CDPHE numeric standard of 0.01 ug/L (which is protective of aquatic life uses within surface water) for total mercury was not exceeded in any surface water sample collected during the Phase I sampling event. The numeric standard was exceeded in two surface water samples collected up-gradient of Rico on the Dolores River during the Phase II (high flow event) sampling event. These two locations are above Barlow Creek and above Silver creek.

- The CDPHE action level for mercury in fish of 0.5 mg/kg (protective of fish) was not exceeded in any of the 44 fish tissue samples collected from four reaches in the Dolores Watershed and analyzed for total mercury.

During the course of producing this document, a thorough research effort was completed in order to identify all possible sources of information. Certain entities often have datasets of use for water quality investigations; however it was found that minimal information was actually gathered in the *Project area*. Sources that were reviewed yet yielded a limited set of records include:

- ***CDOW*** has one recent year's worth of fisheries population survey data, and some data available for 1992 (CDOW, 2006; and CDOW, 1992 as cited in C. Derfus, 2001). The results were folded into the characterization of aquatic life within the *Project area*.

- ***Dolores Water Conservation District*** does not have any information in regards to water quality for the *Project area*. They have referred to Steve Harris/Harris Engineering for information pertaining to the proposed well-field for Rico's municipal supply.

- ***Trout Unlimited (TU)*** has been involved with the evaluation of water rights and the needs for viable fisheries in the lower reaches of the Dolores River. TU has provided information regarding their review of available flow data etc., on their web site (TU, 2006) and was reviewed in regards to information characterizing the fisheries habitat potential in the *Project area*.

- ***USGS QUALDAT*** - a groundwater quality investigation for pesticide occurrence) was reviewed by requesting a query through to the database manager (Arne Sjodin). The database was comprised of groundwater - water quality information that was never integrated into USEPA's STORET database. As per findings from A. Sjodin's query, there were no Dolores County wells inventoried, therefore no data pertinent to this project (A. Sjodin, pers. Comm.. 2006)..

The search for existing information continues during the process of this document being brought together. Conversation with regional USFS personnel indicate that there may be pieces of information gathered from their own studies, and an USEPA 'loading study' conducted several years ago (C. Zillich, pers. Comm.. 2006). To-date however, the points of contact have been unable to locate the information. When and if the information does become available, this document will be updated.

4.3.3 Ongoing Routine Data Collection

As per conversations with various water quality investigative agencies (USGS, CGS, USEPA, CDPHE and CDOW), there are no ongoing site investigations other than those conducted by SEH as part of the St. Louis tunnel area studies (Kelly, B., pers. Communication 2006). There is a proposed sampling effort to characterize soils throughout the river corridor in 2006 – 2007 that may include some stream-side sediment (USEPA). The format and design for the SEH ongoing studies will be the same as those completed in recent years (2002 through 2004) which served as the basis for much of the water quality evaluation within this document.

4.3.4 Ongoing Special Projects

There is an ongoing soils evaluation that is being correlated with resident blood-lead levels. There may be additional soils, and potential sediment studies for the characterization of lead in 2006 – 2007. There was a recent evaluation of mercury within the Upper Dolores River Basin that was made available and incorporated into this document (URS/USEPA, 2006).

4.4 Data Evaluation

The following Section reviews the pertinent data sets available to determine potential water quality impacts associated with the *Project area*. The types of datasets available were previously described (subsection 4.3). These datasets were compiled in this subsection, and interpreted to understand the magnitude of potential water quality issues.

Upon review of the available information, it was determined that the compiled SEH dataset integrates the results from other investigations over time from key locations throughout the *Project area*. This makes the SEH dataset extremely useful for the purposes of this document in order to complete an evaluation of the water quality condition. A summary of the types of sample analysis completed over-time, that are within the SEH dataset were shown in **Tables 4.12 and 4.13**.

In order to be able to characterize the water quality within the *Project area*, it is necessary to have information from locations throughout the watershed that represent the watershed background, tributaries, the possible contaminant sources, and from down-gradient areas. It is also necessary to know the water quality at these locations during unique flow periods such as spring-melt (or high flow) and fall (low flow) in order to understand flow influences to water quality. Once these pieces of information are pulled together, a 'watershed scale' view of water quality over distance, and time can be viewed.

A watershed-scale view of water quality (concentration and load) can help identify data gaps, contaminant sources, seasonal influences etc. For the purposes of this document, it was important to be able to obtain a watershed scale view of conditions. However, as shown within the SEH summary tables, there are 'data gaps' for a number of years, and for a number of locations. Upon review of the available information, it appears that there are fairly robust datasets available for the following years: 1997, 1998, 2002, 2003, and 2004 (refer to **Tables 4.12 and 4.13**). The results for 2005 and 2006 are pending, and further review of 1997 indicates substantial inconsistencies in the suites of analysis completed by site. Therefore, for the purposes of this document, SEH datasets from years 1998, 2002, 2003 and 2004 were relied upon. There are significant uncertainties associated with these datasets however, which are further described in subsection 4.4.3 which presents the data interpretation results.

4.4.1 Introduction

As summarized in subsection 4.3, numerous datasets of varying sizes with differing purposes exist for the *Project area*. An objective of this Watershed Plan, was to review these datasets and determine which contains appropriate information for use in the evaluation of water quality conditions. Many datasets were very 'focused' and served the purpose of an individual study. Thus, they have some, but little overall value in helping to describe a watershed-wide condition. After having reviewed the available information, it was determined that the SEH (2004) comprehensive data set provided the most useful and comprehensive information for the purposes of this document. **Figure 4.3** depicts the locations typically studied by SEH. Other datasets (such as those collected by USEPA, CDPHE, USGS and others) were actually folded into the SEH dataset (SEH), therefore it appears that as much information as is available, is actually present within the SEH data set. A review of individual datasets that were not evaluated as part of this plan are summarized as follows;

- The data sets obtained from each of the **USGS** sites had limited information. Typically, only physical parameters were measured and the results of any analysis were 'averaged', thereby limiting their value. It appears that the USGS data was gathered as part of an ore-body exploration process, and not part of a water quality investigation. Pertinent information (discharge rates from gauging station 09165000 have been integrated into the SEH database. Therefore the pertinent USGS dataset is accommodated by the SEH dataset.

- The available information from the **USEPA STORET Data Warehouse** is comprised of data obtained from various CDPHE and CDOW Riverwatch investigations. The locations with information within the STORET database are shown in **Figure 4.4**. Comparison of the samples results within STORET vs the SEH dataset indicates that the SEH dataset encompasses all of the available information from the CDPHE studies. **Figure 4.5** depicts the CDPHE study locations which overlap with SEH study locations (refer to **Figure 4.3**). The CDOW Riverwatch studies did not have any reportable values and appear to have been gathered from studies conducted within the Dolores area, outside of the *Project area* (**Figure 4.6**). Therefore the results from these efforts were not appropriate to this plan, and were not evaluated.

- The special studies completed by CGS, CFAR and K. Paser were designed to meet specific study goals, and did not lend to being integrated into the water quality dataset compiled for this document. The results from these studies however, provide useful lines of evidence that describe the water quality setting. As such, their conclusions and results are drawn into the evaluation where appropriate.

- There are a number of 'soils' data sets that have useful information from which to characterize the terrestrial setting (Wash Env [1995], AR and CDPHE). This information could be used to estimate the potential soils overland flow impacts to receiving systems. Soils could be transported to streams by *Stormwater* and snow melt discharges. These soils in turn could become a source of sediment and sediment contamination, if the soils have contaminant issues. Simplistic models could be applied to determine if this pathway is of potential concern, but is beyond the scope of this document. The analysis of this potential pathway is a 'recommendation for next steps' as identified in **Section 7.**

In summary, it appears that the available water quality information relevant to the *Project area* is best represented by the SEH dataset. As previously mentioned, the most comprehensive datasets available occur in the years of 1997, 2002, 2003 and 2004. The data available from these years was evaluated by two general methods; 1) water quality comparison to criteria and 2) metals loading analysis to determine the gain or loss of metals over time and distance. The specific methods to these approaches are described in detail in subsection 4.4.3.

4.4.2 Water Quality Discussion

As shown by the abundance and type of data collected over the years, there are distinct features within the watershed that have captured the attention of others. These features create point or nonpoint sources of pollutants to the watershed and have raised a concern with private and regulatory and resource agencies. The list of some of the features that have created concern and have water quality issues associated with them include;

- The St. Louis Tunnel discharge adit: CDPHE and others have extensively studied this feature. At times the metals load from this adit comprises upwards of 80% of the total metals load within the Dolores River within the Rico area.

- Newman Hill area – Syndicate tunnel and Lexington mine dump – seeps out of the mine dumps etc. demonstrate mineral deposition (calcite deposits)

- Columbia tailings – which are located within the Dolores River Corridor, have been capped as per a VCUP action (1996). Of potential concern however, is the proximity of these tailings to the river which has been identified as an ongoing hazard (Matrix) since the flows from the river have compromised the cap and exposed tailings which are reaching the river, and due to the potential for groundwater infiltration into these tails that can become degraded and subsequently impact water quality within the adjacent surface waters of the Dolores River. This site has been dedicated to the town and will be the location of future development for a hotel site.

- Propatriot Mill Site which is located immediately adjacent to the river corridor, has been tested by the USEPA and others and has metals enriched soils as a result of historic smelting operations. It is unknown the contribution of water quality concern associated with this site since data are lacking and the site is physical 'set back' from the drainage path. There is the potential for overland flow of contaminated soil into the receiving drainage, and groundwater infiltration, degradation and subsequent impact to the surface water of the Dolores River. Potential future development activities on this property (the area may become the site for a River lodge, hot springs, facility, green house and other features) may provide a protective step towards severing water quality impact pathways. With the placement of impervious cover, the potential for overland flow of contaminants will be minimized. The potential for groundwater impacts however, will remain.

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- Rico Boy and Santa Cruz Adits have had a VCUP which included consolidation of mine waste, capping and routing of adit flows. The flows are combined, routed to a single settling pond and eventually release to a wetlands area associated with the Dolores River. There are metals associated with this release that do reach the Dolores River.

- Silver Swan Adit has had a VCUP involving the consolidation of mine waste, capping and routing of adit flows to a wetland associated with the Dolores River. The site occurs below gradient to the Rico Boy/Santa Cruz site. The site does contribute metals load to the Dolores River.

- Mountain Springs Mine was identified by the CGS/USFS as presenting an environmental hazard due to hazardous constituent characteristics associated with the waste and adit flows. The flows do reach the Dolores River during portions of the year. There is little to no further information available for the Site.

- Within the Silver Creek Catchment there are a number of mine features as yet unstudied. An unnamed adit located below the overhead tramway (identified by SEH) contributes significant amounts of metals to the Silver Creek flows. The Argentine tunnel and waste pile site has a seep that contributes to the metals within Silver Creek as well. The flows and metals load associated with this Site are seasonally affected.

- The Blaine Tunnel feature had an historic adit release up until it was plugged thereby rerouting the adit discharge to the St. Louis. This tunnel currently has a slight seep which discharges as a nonpoint source to the Silver Creek basin. Current conditions of seep discharge water quality impacts to Silver Creek are unknown but considered to be slight given the low magnitude of release.

The sampling that has been conducted within the *Project area* is largely focused upon these above listed sites. There are other areas (i.e. Horse Creek and Scotch Creek) that have had singular sampling events for specific purposes. Otherwise, the amount of data available for the *Project area* is very focused and relatively confined to the historic mining district area.

4.4.3 Potential Effects to Designated Uses

If the surface water quality of a resource is degraded, the designated uses of that water body is impaired (and can lead to the listing of the impaired segment on the CWCB 303(d) list, as well as have other ramifications. The data compiled from the various sources was compared to standard criteria associated with the designated uses of the surface water bodies within the *Project area*. The designated uses of the in-stream flows are;

- Potable supply

- Irrigation/agricultural
- Class 1 coldwater fisheries

The 'class 1, cold water' standards from CWQCD are protective of aquatic life. These concentrations are similar to those for domestic drinking-water supplies but are more restrictive for elements such as copper and zinc that affect aquatic life more than human health, and more stringent than for agricultural use. Thus, if the measured concentrations of constituents fall below the aquatic life standards, typically the other designated uses are protected for as well.

Comparison of measured constituent concentrations to these standards is an 'inferential' method to determine the potential for an adverse effect. It is not a definitive expression of effects, rather an indicator that further evaluation is required. The composition of streams (biological components, habitat characteristics) is an indicator of impact and ecosystem health. In practice, it is much easier to determine water constituent concentrations than to measure biological communities such as benthic macroinvertebrates and fish which are a better indicator of 'designated use' achievement (Besser et al., 1998; Boyle and Bukantis, 1998; and Nash, 2002).

For the purposes of this evaluation, effects to the cold water, class 1 designated use were completed by two methods;

1) measured concentrations of dissolved metals were <u>directly compared</u> to hardness-derived AWQC values to identify possible constituents of concern, and

2) a <u>copper-zinc index</u> (CZI) was formulated using available data.

Since the designated use of the *Project area* surface water segments are protected by numeric standards, and not biological criteria, these two methods were considered as appropriate screening tools. If biological information were available, it would serve as a more direct and definitive measure. However, this information is largely absent and has current, limited usefulness. The following describes the methods and results of the two methods applied to determine effects to the *Project area* designated uses.

The <u>direct comparison</u> method utilized the 'hazard quotient' tool in which the measured concentration was divided by the appropriate chronic AWQC value. An HQ is expressed as the ratio of a potential exposure point concentration of a given metal to the criterion protective of chronic exposure for aquatic life receptors and is derived using the following equation:

Eqn. 4.1 HQ = [Metal in site water]/[Site-specific chronic AWQC]

Where;

HQ = hazard quotient (unit less),

The metal concentration in water is expressed in similar units (either ug/L or mg/L) as the comparative AWQC, and is representative of the appropriate 'fraction' (dissolved or total) as the AWQC, and

Site specific chronic AWQC values were developed for Silver Creek, St. Louis tunnel and the Dolores River locations, for the hardness-derived AWQC for cadmium, copper, lead, zinc; while drainage-specific AWQC were used for the remaining metals of arsenic, chromium, iron, manganese and selenium.

A second method applied within this assessment involved the development of a copper-zinc index (CZI). The CZI has been described by others (Besser, 2000) as an index that provides a simple number that describes the magnitude of copper and zinc concentrations in water samples in relation to aquatic life requirements as determined by toxicological tests. The intent of the CZI is to focus on two metals of prime concern to aquatic health typically associated with Colorado mining areas (NASH, 2002) while minimizing regulatory details of water-quality standards. The CZI is calculated as:

Eqn. 4.2 $$CZI = [(Cu \text{ in ug/L}/20) + (Zn \text{ in ug/L}/200)]/2$$

Where;

CZI = Copper-Zinc index (unit less)
Cu = the concentration of copper in ug/L
Zn = the concentration of zinc in ug/L

The values of 20 and 200, for copper and zinc respectively, are not precisely defined, but are essentially average values for tolerant and sensitive species in mortality tests and are similar in magnitude to the aquatic life standards. The sum is divided by two to conveniently make the index 1 for the break between healthy and unhealthy compositions: CZI values below 1 are 'good', and values above 1 are 'bad'.

Hazard Quotient Results

Summaries of the aquatic life criterion were provided in **Tables 4.2 through 4.4**. Site-specific criterion for certain metals were derived using site-specific hardness values. The remaining metals (not hardness dependent) had basin-specific standards from CWQCC table standards for the Upper Dolores segments. Therefore, in summary, the AWQC values presented in the HQ tables reflect site-specific and region-specific standards.

Tables 4.14 through 4.22 were drawn from SEH data set summaries from both high and low flow sampling events at the St. Louis Tunnel area, Silver Creek and along the Dolores River. Results from metals analysis are presented within these Tables, by location, and compared to appropriate chronic AWQC levels. An HQ less than one indicate that the metal alone is unlikely to cause adverse effects to exposed aquatic life.

An HQ of greater than one indicates the need for further evaluation since a toxicity potential exists.

CZI Results

The CZI results for each event(high and low flow) for each year was calculated by sampling location (**Table 4.23**). The results provide a conceptual indication of source areas that lend potentially toxic levels of copper and zinc. This metric is only a conceptual measure and not a true indication of toxicity.

Loading Results

The hydrogeologic interpretation of loadings in the setting of the *Project area* is complex. First off, accurate loadings require precise co-located measures of metals concentrations and flows. For the purposes of this effort, certain flows were absent, as well as certain metals constituents were erratically measured (they would be measured upstream, but not below etc), thus the key components were pulled together and at times, represent a 'piece meal' loading model. In addition, the calculated TOTAL load measured for the *Project area* is not attributable to a single or specific source. Flow paths of metal-rich water from adits, mine wastes and mill tailings at or near the stream course may appear straight forward, but the presence of the mine waste pile on the stream bank may mask a groundwater contribution from a fault or open adit that is concealed by the mine waste pile for example. Flow paths from anthropogenic sources located some distance from the stream (i.e. more than 1 km) may be even less certain. In general, our certainty about flow-paths from specific sources decreases as the distance between the assumed anthropogenic source and the stream increases.

4.4.4 General Trends

The following discusses trends in water quality as observed by the type of data analysis (hazard quotient, CZI, and loading). **Figures 4.7 through Figure 4.11** demonstrates the change in concentration for iron, manganese and zinc each year by location. A narrative description of the concentration trends is provided below.

Hazard Quotient Discussion

The following provides a review of the water quality findings for the St. Louis tunnel and outfall, Silver Creek and the Dolores River. Consistent data of high quality was available for these areas from 2002 through 2004. Trends were observed in concentrations of certain metals by location and season (samples were typically collected during high and low flow periods). The resulting information serves to identify possible source areas of degraded water quality that need further study or possible remedy.

St. Louis Tunnel and Outfall

An HQ of greater than one indicates the need for further evaluation since a toxicity potential exists.

CZI Results

The CZI results for each event(high and low flow) for each year was calculated by sampling location **(Table 4.23)**. The results provide a conceptual indication of source areas that lend potentially toxic levels of copper and zinc. This metric is only a conceptual measure and not a true indication of toxicity.

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The hydrogeologic interpretation of loadings in the setting of the *Project area* is complex. First off, accurate loadings require precise co-located measures of metals concentrations and flows. For the purposes of this effort, certain flows were absent, as well as certain metals constituents were erratically measured (they would be measured upstream, but not below etc), thus the key components were pulled together and at times, represent a 'piece meal' loading model. In addition, the calculated TOTAL load measured for the *Project area* is not attributable to a single or specific source. Flow paths of metal-rich water from adits, mine wastes and mill tailings at or near the stream course may appear straight forward, but the presence of the mine waste pile on the stream bank may mask a groundwater contribution from a fault or open adit that is concealed by the mine waste pile for example. Flow paths from anthropogenic sources located some distance from the stream (i.e. more than 1 km) may be even less certain. In general, our certainty about flow-paths from specific sources decreases as the distance between the assumed anthropogenic source and the stream increases.

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<u>St. Louis Tunnel and Outfall</u>

Samples were routinely taken from the tunnel mouth and the outfall. The results provide an indication of the effectiveness of the settling ponds in regards to passive treatment of metals in solution. The settling ponds allow for 'time and distance' for the metals in solution to react with other water quality parameters (and solids) and either stay in solution (where they can be toxic to exposed organisms) or settle out as a precipitate in the bottom of the ponds.

- **For the year of 2002 – Table 4.14**: From the tunnel sampling location to the outfall, concentrations of arsenic, cadmium, chromium, copper, iron, lead, manganese and zinc decreased significantly, while hardness increased (indicating the establishment of buffering capacity) for both spring and fall .

- **For the year of 2003 – Table 4.15**: Data was available for fall, low flow conditions only. From the tunnel location to the outfall, concentrations of cadmium, chromium, copper, iron, lead, manganese and zinc decrease, while concentrations of mercury, nickel, selenium and silver increased (along with hardness). These increases were slight, yet highlight the unique water chemistry associated with these elements. It is possible that pH in the various ponds could have affected the solubility of these elements. It is also possible that the analytical results are at levels low enough to cause analytical error. Regardless, the released concentrations of mercury, nickel, selenium and silver at the outfall are not of concern in regards to their concentration and thus, potential effect to aquatic life. [An additional note as provided by Atlantic Richfield's review of this information: "Mercury concentrations in sampling completed along the Dolores River and at the St. Louis Ponds have been reviewed in relationship to detection of mercury in field blanks. It should be noted that the level of mercury in the St. Louis Ponds discharge has actually been less than that in associated blanks which according to EPA guidance for Method 1631 ultra-low level analytical procedures employed, suggests that the slight rise noted in the above citation was based on invalid data].

- **For the year of 2004 – Table 4.16**: From the tunnel location to the outfall, concentrations of cadmium, copper, iron, manganese and zinc decreased significantly in spring and fall. Concentrations of selenium increased in spring, and concentrations of lead and silver increased in fall. Again, similar to the findings from 2003, the increases observed (for selenium, lead and silver) were slight. The concentrations of these metals at the outfall point of release were low and not of concern to exposed aquatic organisms. These increases may be the result of a dynamic equilibrium related to pond pH, the precipitates present, and/or due to analytical error.

Results indicate that the settling ponds are significantly affecting the amount of available metals in solution. The current operating conditions seem to be addressing a significant portion of metals associated with the tunnel. The water quality at the point of release (the outfall) from a concentration standpoint shows acceptable levels for aquatic life. The amount of 'load' however, needs further evaluation. In addition, the potential settling pond sediment release is a point of consideration since over-topping, or breaching of the settling pond berms would release significant precipitated metals from the ponds to the Dolores River. This condition was previously observed (year) and remains a potential threat to the *Project area*. [Additional information provided by Atlantic Richfield's review of this document states "The focus of the ongoing water quality assessment by DEPHE for the St. Louis Ponds has been to identify the metals loads that can be released under a discharge permit and still be protective of the Dolores River. This effort is anticipated to be completed sometime in 2007. Atlantic Richfield has taken steps to alleviate the potential for overtopping of the berms, enhance spillway protection and control beaver activity within the site.]

Silver Creek

The samples collected from Silver creek were somewhat erratic. In general, samples were taken during high and low flow periods from locations at points of potential mine-site water releases. On occasion, samples were taken above (SVS 1T) and at (SVS 1) the Town of Rico potable supply intake. In addition, a location at the terminus of Silver Creek, immediately prior to the confluence of the Dolores River was routinely evaluated. Comparison of water quality results from these locations provides an indication of potential degraded water quality source areas.

- **For the year of 2002 – Table 4.17**: Concentrations of cadmium and copper tended to 'spike' at location SVS 26 which is associated with a seeping mine adit during both spring and fall flow conditions. Similarly, concentrations of iron, manganese and zinc spike at SVS 12; the Argentine tails seep, and SVS 26 (the open adit) during both high and low flow conditions. During low flow, mercury, silver and nickel show spikes in concentrations (with SVS 26 and 12 depending upon the metal) indicating that the concentrations of these metals are subtle and can only be observed during low flow conditions when dilution is at a minimum. Concentrations of arsenic, selenium, cyanide and lead were erratic and difficult to understand in relation to source areas. Therefore, these metals were defined as showing 'no trend' for Silver Creek. In ALL CASES, the metals that demonstrated spikes at particular locations, eventually decreased in concentration as you progress down-gradient to the Dolores River. The water quality at the point of release to the Dolores River is good and had concentrations of metals of little to no concern to exposed aquatic life. There are data gaps however, that need to be resolved in order to understand the metals concentrations and release rates to the Dolores River.

- **For the year of 2003 – Table 4.18**: Only low flow, fall sampling was conducted. Therefore there is a data gap in understanding water quality conditions during high flow. Results from the low flow sampling indicate that SVS 22 (Silver Creek above Argentine tailings seep) and SVS 26 are source areas for metals. Concentrations of cadmium, copper, iron, lead and manganese all increase at these two points. This data set has significant data gaps for certain metals including arsenic, silver, cyanide, mercury, nickel, selenium and zinc. No further analysis could be completed.

- **For the year of 2004 – Table 4.19**: Concentrations of cadmium, copper, iron, manganese and zinc spike at locations SVS 22 and SVS 26 during both spring and fall flow conditions indicating significant source areas. Lead also showed spiked (increased concentrations as compared to the location above) concentrations in the fall when there was less dilution associated with the Silver Creek flow. The actual amount of load contributed by SVS-26 constitutes a very small percentage of the total Silver Creek metals load. No trends were observed for silver and selenium, and chromium demonstrated fluctuating concentrations which were difficult to relate to any source area. There were data gaps for arsenic, cyanide, mercury and nickel. All of the metals that showed various increases (cadmium, copper, iron, lead, manganese and zinc) decreased in concentration at the lowest sampling location which is immediately prior to Silver Creek's release into the Dolores River (similar to the trend observed in 2002). This indicates that Silver Creek has an assimilative capacity created by increased flow (dilution) and buffering capacity (leant by travel time and distance, and increased hardness and possibly alkalinity).

Results of the Silver Creek hazard quotient analysis indicate that there are source areas within this catchment that are releasing metals into solution. These source areas seem to routinely be associated with the Argentine tailings seep area, and an unnamed adit below the Argentine, but above the Dolores River confluence. There is an assimilative capacity within the water quality of Silver Creek that provides significant dilution and buffering of these metals concentrations. Metals levels at the point of release are typically at levels of low to no concern. The only metal that poses a potential risk to aquatic life is zinc (which yields HQs of 3 to 8 as compared to chronic AWQC values). There are data gaps for certain metals and for certain flow regimes which makes these conclusions uncertain. There is the need for further analysis to delineate the source areas more thoroughly. [Additional information provided by Atlantic Richfield indicates that "Analyses performed as part of the St. Louis Ponds water quality assessment indicate that appropriate and protective permit limits can be established for the St. Louis Ponds discharge without specifically accounting for the metals loadings from Silver Creek to the Dolores River (like the minor seep/adit loadings discussed elsewhere). It is also recognized that there is a TMDL process initiated for Silver creek that will appropriately examine water quality issues and identify potential best management practices.]

<u>Dolores River</u>

The sampling locations along the Dolores River changed over time. In general, there were routinely available sample results from locations above, adjacent to and below the St. Louis ponds; above the Silver Creek confluence, directly associated with nonpoint and point releases associated with features such as the Columbia tailings, Santa Cruz adit, Rico Boy adit and the Swan adit, and one location occurred below gradient that captured the water quality condition of the entire system. The locations sampled varied by year and appear to be associated with the work completed on the Columbia tailings, Santa Cruz and Rico Boy adits. The combined flows of the adits are routed into a settling pond, then a wetland. The locations sampled by year appeaer to vary depending upon where flow occurred within the pond and wetland setting. Results were evaluated by year as follows;

- **For the year of 2002- Table 4.20, and Figures 4.7 and 4.8** demonstrates the change in iron, manganese and zinc at each sampled location during high and low flow. The water quality 'above' the footprint of the mining area (which begins with the St. Louis tunnel and settling ponds) is of good quality, but contains low levels of cadmium, iron, manganese and mercury indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes iron and manganese to the Dolores River. These concentrations are slight however. Distinct spikes in iron, manganese and zinc are observed during both high and low flow conditions for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan adit. Significant copper releases occur during high flow indicating a surface water carriage/source related condition, while cadmium demonstrates a chemistry that appears to be groundwater related (and of concern during low flow conditions). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for cyanide and nickel, and there are data gaps for mercury and arsenic.

- **For the year of 2003 - Table 4.21 and Figure 4.9** demonstrates the change in iron, manganese and zinc at each sampled location during low flow. There was only data available for fall, low flow conditions. Water quality 'above' the footprint of the mining area is of good quality, but contains low levels of chromium, copper, iron, manganese, mercury, selenium and zinc indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes cadmium, chromium, iron, manganese, mercury and zinc to the Dolores River. Distinct spikes in iron, manganese and zinc are observed for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan adit. Cadmium and zinc also demonstrate a spike at the Rico Boy/Santa Cruz combined flow outfall. Increased concentrations of copper were associated with the Columbia and Silver Swan adits. Copper and manganese demonstrate a steady gain during these low flow conditions, beginning at a location adjacent to the settling ponds. This indicates that there are several possible sources (natural, groundwater seepage and surface water carriage). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the

Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for chromium, lead, silver and selenium and there are data gaps for arsenic, cyanide, mercury and nickel.

- **For the year of 2004 – Table 4.22 and Figures 4.10 and 4.11** demonstrates the change in iron, manganese and zinc at each sampled location during high and low flow. The water quality above the footprint of the mining area is of good quality, but contains low levels of arsenic, iron, manganese, mercury, selenium and zinc indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes iron, manganese and zinc to the Dolores River. Distinct spikes in iron, manganese and zinc are observed during both high and low flow conditions for the St. Louis outfall, Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet(s), and the Silver Swan adit. Significant cadmium, copper, manganese and zinc releases occur during high flow from the Rico Boy/Santa Cruz mine. Cadmium and lead demonstrate a chemistry that appears to be groundwater related (and of concern during low flow conditions). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for chromium, selenium and silver, and there are data gaps for lead, mercury, nickel and arsenic.

The results demonstrate some similar trends each year. Certain metals steadily gain during low flow conditions indicating a groundwater related source mechanism. These concentrations are subtle and of little to no concern to exposed aquatic life. There are distinct source areas and metals that are associated with them. For instance, copper and zinc are typically associated with both high and low flow releases from the Rico Boy/Santa Cruz combined flow. Iron and manganese are associated with the St. Louis outfall, Columbia, Rico Boy/Santa Cruz and Silver Swan. These trends were observed typically each year. There are data gaps for certain metals and inconsistent trends for others. The reach from the St. Louis to Silver Creek represents a data gap and an area that may be contributing groundwater related metals. The areas below Silver Creek to the Silver Swan appear well characterized and highlight source areas requiring further study.

CZI Discussion

Table 4.23 provides a summary of the calculated CZI values by sampling season (and year) and location. Values greater than 1 indicate the need for further evaluation, since the measured concentrations of copper and zinc occur above benchmarks protective of aquatic life. Results are described by drainage area (St. Louis tunnel and outfall, Silver Creek and the Dolores River) as follows;

- Results for the St. Louis outfall and tunnel indicate that copper and zinc levels are of potential concern at both the tunnel and the outfall. These results are consistent each year and coincide with the HQ results previously described.

- Results for Silver Creek highlight the need to further evaluate the unnamed adit (identified by SEH as being located below the overhead tramway) and the Argentine seep. Consistently elevated levels are associated with both of these locations.

- Results for the Dolores River sampling areas indicate that there is a need to evaluate the copper and zinc releases associated with the Rico Boy/Santa Cruz outfall areas. The measured values yield CZI levels above 1 every year where sufficient information was available.

In summary, the CZI findings support the Hazard Quotient (HQ) discussion in the previous subsection. The same source areas are highlighted for each drainage area. These results indicate the need for further evaluation of the water quality associated with these sources.

Loading Discussion

Loading was calculated for a data set from 1997, and the SEH datasets from 2002, 2003 and 2004. The data sets from 2002 forward were evaluated to determine current trends, and were compared to the 1997 data to determine temporal (change over time) trends. The individual sample analysis results in a given data set (i.e. from the low flow sampling of 2003) were used to determine load from specific sources and the trend of metals gain or loss over distance.

The following first describes 'temporal' trends as observed from 1997 to 2002, 2003 and 2004 data set comparisons, and then individual year loading analysis. For a loading analysis to be accomplished, co-located water sample results for metals and flow need to be gathered. Such was not always the case within these data sets. There were significant uncertainties associated with each data set. These uncertainties are described within each subsection. There were enough combined uncertainties to lend to the formulation of the recommendation to gather a comprehensive watershed scale monitoring effort.

Temporal Trends

Table 4.24 provides a comparison of individual metal loading units (lb per cfs) for iron, manganese and zinc from two locations within the Dolores River that occur above the Columbia tailings (DR-2-SW) and below the Swan adit (DR-4-SW). These two locations had consistently available data for the metals and for flow, and represent Dolores River water quality conditions. Unfortunately there were no consistent data further above within the Dolores River, or below; therefore this analysis brackets the load within the impacted area of the Dolores River, and captures and load contributed by the St. Louis tunnel, and outfall and Silver Creek. None-the-less, this information does provide at least a snap shot of the potential changes that have occurred since 1997. Results indicate

- **Iron**: Comparison of iron load from the upstream (DR-2-SW) to the downstream (DR-4-SW) location has shown increased load during 1997, 2003 and 2004. The rates of increase for these years were comparable (0.31, 0.27 and 0.30) indicating that there has been little to no measurable decrease in load over this span of time. There was a slight decrease measured from upstream to downstream in 2002. This may be due to uncertainty associated with flow measurements, or low flow releases due to the drought conditions.

- **Manganese**: Comparison of manganese load from the upstream to downstream location has shown increased load during all years (1997, 2002, 2003 and 2004). The year 2002 demonstrated a significantly low rate of increased load. Similar to iron, this may be attributable to the affects related to the drought. The years 1997, 2003 and 2004 all had similar measures of load increase indicating that there has been little to no measurable decrease in load over this span of time.

- **Zinc**: Comparison of zinc load from the upstream to downstream location has shown increased load during all years (1997, 2002, 2003 and 2004). The year 2002 demonstrated a significantly low rate of increased load. Similar to iron and manganese, this may be attributable to the affects related to the drought. The years 1997 and 2003 had similar measures of load increase indicating that there has been little to no measurable decrease in load over this span of time.

Results from the temporal analysis indicate that that iron, manganese and zinc load has been erratic over the years. The comparison of these datasets does not demonstrate a trend towards depletion. The amount of these metals fluctuates significantly, and does not show any steady decline. This may demonstrate that metals load has not decreased as a result of any mine-related remedy efforts completed to-date need to further evaluate remedy efforts and construct additional remedy efforts to control these loads.

<u>Individual Annual and Location Trends</u>

Further analysis of load by location, by event and year is as follows;

- **For the year of 2002: Figure 4.7 and 4.8** demonstrates the change in iron, manganese and zinc load at each sampled location during high and low flow. There are <u>uncertainties</u> associated with the data sets from 2002 as follows;

  ✓ **Both sampling events represent low flow conditions.** Flows during July, 2002 and October, 2002 are comparable. Therefore, there is no true high flow sampling event within this data set. This may be due to the fact that this was a significant drought year which yielded very minimal spring-melt flows.

✓ **For the July, 2002 data set, there is a lack of flow information for key locations which bracket the water quality footprint of effects associated with the St.** Louis tunnel (missing flow data for DR 20, DR 2, DR 7, DR 6 and DR 3). This again, may be due to the fact that this was a significant drought year, and flows were at a minimum and perhaps difficult to measure.

Results from the 2002 sampling events were difficult to interpret due to the uncertainties associated with them for both the July and October sampling events. The results from the July effort did not capture the Upper Dolores setting surrounding the St. Louis tunnel (flow measures were lacking) therefore no conclusions were drawn. The July results from the lower Dolores River capturing the Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these two point sources are potentially significant sources of zinc load, however the percent contribution could not be determined due to a lack of flow measurements at points downstream of these releases. Results from the July Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient. It is unknown as to how much load Silver Creek contributed to the Dolores River due to the lack of flow data at the sampling location immediately down-gradient (DR-2-SW).

For the October, 2002 sampling event results for the upper Dolores which captures the St. Louis ponds were lacking information for sample points adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. Due to the lack of zinc data below the outfall (from DR 7) the load contribution to the Dolores River could not be determined. Review of sample results around the confluence of Silver Creek identify an error in the flow measurements. There is roughly a 5 lb contribution of zinc that is unaccounted for between the Silver Creek outfall, and the sampling point representing the Silver Creek mixing zone (2-SW). The October results from the lower Dolores River capturing the Columbia tailings, Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these sources contain significant metals load, but it is controlled by the wetlands which buffer their release to the Dolores River. Results from the October Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient, but remains a significant source to the Dolores River with a percent contribution of zinc at 25% 2.19 lbs of 8 lbs measured at DR-2-SW).

- **For the year of 2003: Figure 4.9** demonstrates the change in iron, manganese and zinc load at each sampled location during low flow. There are uncertainties associated with the data sets from 2003 as follows;

  ✓ **Only one sampling event representing low flow conditions was captured.** This sampling event blended from October through December which introduces a temporal uncertainty. The sampling likely represents several time periods and may have limits to its comparability.

  ✓ **For the 2003 data set, there is a lack of flow information for key locations which bracket the water quality footprint of effects associated with the St. Louis tunnel** (missing flow data for DR 20 and DR 2, and zinc analysis for DR 20 and DR 2).

For the October through December, 2003 sampling event results for the upper Dolores which captures the St. Louis ponds were lacking information for sample points adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 0.59 lbs of zinc is significantly less than the zinc load of 3.65 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to an 83% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a significant contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 5.65 lbs of the measured 11 lbs, contributing 51% of the load. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these sources release are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. These results emphasize the importance of the wetlands buffer zone associated with these point discharges. The load contribution attributable to the Columbia seems very slight, yet measurable. It is apparent that the tailings seep is an ongoing contributor to the zinc load. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

- **For the year of 2004: Figures 4.10 and 4.11** demonstrates the change in iron, manganese and zinc load at each sampled location during high and low flow. There are <u>uncertainties</u> associated with the data sets from 2004 as follows;

  ✓ **For the 2004 data set, there is a lack of flow information for key locations and some error in the flow measurements** (missing flow data for DR 2, and zinc analysis for DR 20 and DR 2). The measured flow levels are higher up-gradient than in down-gradient areas which indicate a possible error in the values.

  ✓ **December was the determined time period from which low flow conditions were sampled. This time period does not represent true low flow conditions since snow melt can dilute the samples and affect measured flow rates.**

  ✓ **The measured values of zinc from the locations within the Dolores River (specifically DR 1, DR 20 and DR 2) are suspect.** The results indicate below detection limit values for zinc, which is unlikely for this particular element. Further analysis of the analytical records needs to be conducted to determine if the detection limits were suitably low.

Results from the 2004 sampling events were the most valuable dataset since there were two distinct flow events captured, with relatively comprehensive information being obtained. For the April, 2004 sampling event results for the upper Dolores - St. Louis ponds is lacking information from locations adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 6 lbs of zinc is significantly less than the zinc load of 16.8 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to 64% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a potentially significant contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 17 lbs of zinc, however only 9.95 was measured at the confluence indicating a significant dilution provided by the Dolores River. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these source releases are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. The load contribution attributable to the Columbia seems very slight, yet potentially significant (with a load of 26 lbs associated with its flow). Of particular interest are the results from the lower-most Dolores River sampling location (DR-4-SW) which yielded very elevated zinc load levels (53 lbs). Looking up-gradient, it is difficult to identify the sources with the information available. During a site visit, fluvial tailings were observed along this reach and may be a nonpoint source area. The results from DR-4-SW highlight the need for 'point of release' results for the Silver Swan, and from locations within the Dolores River channel above and below point releases. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

For the December, 2004 sampling event results for the upper Dolores which captures the St. Louis ponds yielded below detection results for zinc for sample points adjacent to the ponds. Zinc is a common metal that typically occurs in most natural waters at detectable levels. These results may be accurate, but seem suspect. Further analysis of the original analytical records needs to be reviewed to determine if the analytical detection limits are suitably low. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 'non-detect levels' or '0' load lbs of zinc is significantly less than the zinc load of 24 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to 240% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a minimal contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 1.38 lbs of the measured 29 lbs, contributing 5% of the load. This indicates that the high flow conditions within the Dolores (possibly due to snow melt), dilute the effects of the very low flows within Silver Creek, and carry the most significant load of zinc within the Dolores River flows themselves. This may be an artificial representation of true low flow conditions given the dilution created by the snow melt. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these source releases are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. The load contribution attributable to the Columbia seems very slight, yet measurable. Of particular interest are the results from the lower-most Dolores River sampling location (DR-4-SW) which yielded very elevated zinc load levels (40 lbs). Looking up-gradient, it is difficult to identify the sources with the information available. The results from DR-4-SW highlight the need for 'point of release' results for the Silver Swan, and from locations within the Dolores River channel above and below point releases. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

2

Results of the above indicate the following trends by nonpoint and point source feature;

- The St. Louis settling ponds are losing water to either or both the Dolores River or the groundwater. As shown in **Tables 4.25 and 4.26** there are measured flow losses between the tunnel (DR 3) and the point of discharge (DR 6) to the Dolores River. As shown in **Table 4.25**, the amount of flow loss ranges from 38 to 85 % and indicates that the ponds are not capturing and containing all of the tunnel flows. It is unknown of the waters are seeping directly from the ponds to the Dolores River, or into the underlying groundwater which will also release to the Dolores River. This is a significant concern given the water quality associated with the tunnel water. These results indicate that the St. Louis tunnel and associated settling ponds are a potentially significant contributor of metals load to the Dolores River. As shown in **Table 4.26**, there is a metals load loss that is likely, largely attributable to the settling ponds, but also may be an indication of load lost to the Dolores River. These results indicate the need for addition remedy efforts to capture and control the tunnel water.

- The Rico Boy/Santa Cruz mine sites have had a VCUP action that has consolidated the mine waste, capped the materials and tried to control adit flows as well as run-on and run-off *Stormwater* flows. At the time of the production of this document, these sites were visited and observed during both high and low flow settings (further described in **Sections 6 and 7**). The adit flows from these two mines, are combined and routed into a singular settling pond. From there, the flows go into a well-vegetated wetland before entering the Dolores River. This setting creates a combination of both point and nonpoint sources of water contamination as related to these sites. The water quality information indicates that the settling pond and wetlands are serving as a good buffer to controlling metals releases from the mines to the River. Wetlands however, have a seasonal limitation during winter conditions when the vegetation dies back and can not serve as a buffering capacity. The water quality released from these mines is of concern and is causing degraded water quality within the Dolores River. This system needs to be further evaluated and reviewed in regards to the effectiveness of the current remedy.

- The Columbia tailings are a significant body of tailings that has had a VCUP associated with it. Historic information indicates that a side channel associated with these tails had significantly degraded water quality. The current conditions regarding this site are not known and need review. It is likely that the VCUP cap has curtailed a significant amount of nonpoint source from this feature, however zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

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- Silver Creek contains a number of mine-site related features requiring further evaluation and possible remedy. A significant amount of VCUP work has been completed with the Argentine tunnel and tailings. There remains however, a significant seep from the tailings that runs parallel and eventually reaches a confluence with Silver Creek. This seep is a source of metals and is a water quality concern. Further down-gradient, as per SEH study and findings, there is an unnamed adit that releases significantly degraded water quality into Silver Creek. The underground workings and setting related to this feature are unknown and require further evaluation. Silver Creek does appear to have an assimilative capacity in that a significant portion of the metals load from these up-gradient sources is abated over distance. This is likely due to increased flows creating dilution and perhaps due to improved buffering capacity. Further evaluation of the load contribution contributed by Silver Creek during different flow regimes is required.

- The Silver Swan Mine is similar to the Rico Boy/Santa Cruz mine sites in that it has received much attention in the form of VCUP actions and investigative studies. This site also is a mix of nonpoint and point source releases to the Dolores River. This Site has the capacity to release significantly degraded water quality to the Dolores River and does not have as much of a wetlands buffered capacity as the Rico Boy/Santa Cruz. Further study and evaluation of the VCUP remedy effectiveness is required.

- There are other potential mine-related nonpoint sources such as mines located above the St. Louis ponds, the Propatria Mill Site etc. that may be contributing slight metals load increases. A thorough loading analysis within the Dolores River Channel is needed in order to tease out the possible contributions associated with these sites.

Potential Future Issues

The potential future water quality issues are summarized as follows;

- Unless the mine-site related nonpoint and point sources are controlled or abated, the metals loading and resulting concentrations will continue and remain an issue. Of particular concern is the potential for the St. Louis ponds to breach their containment and release significant amounts of precipitated metals downstream into the Dolores River. Of secondary concern are the point sources related to the unnamed adit within Silver Creek, the Rico Boy/Santa Cruz outfall, and the Silver Swan, and the nonpoint sources related to the Argentine tailings seep (within Silver Creek) the Columbia tailings area and combined groundwater discharge to the Dolores River.

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potential Future threat to Dolo R.

- There are other potential future impacts associated with the planned WWTP discharge (discussed in the following Section) as well as uncontrolled nonpoint sources related to stormwater releases (discussed in **Section 6**).

4.5 Summary of Recommendations

This Section served the purpose of locating and evaluating all available information that describes the water quality setting within the *Project area*. The Section began with an overview of the regulatory applications and presents the current water quality standards that apply to the designated uses and designated segments of streams and the Dolores River. As described, the regulations are still in a state of 'flux' and would benefit from the information provided within this document, as well as the contributions provided by the Town of Rico.

This Section goes on to compile the available information and use it to determine existing water quality conditions. As summarized previously, there have been a significant number of studies completed, however each served their own distinct purpose. It was only until the SEH data collection efforts were completed, that a more 'watershed-scale' level of information was obtained. It was these SEH data sets that were ultimately relied upon to characterize the water quality setting. These data sets however, were very focused in their footprint of activity (starting above the St. Louis ponds and terminating just below the Silver Swan adit) which leaves significant portions of the *Project area* without characterization (pending data gap).

Results of the SEH studies assisted significantly in the identification of metals-contaminant related source areas. As shown from the hazard quotient, CZI and loading analysis, The St. Louis ponds, and Silver Creek are significant contributors as a whole to the metals load within the Dolores River. Detailed analysis reveals that the ponds are very effective at controlling the amount of metals released to the River. Silver Creek has at least two uncontrolled source areas associated with the Argentine tailings seep and the unnamed adit below the overhead tramway. The Dolores River has several point sources (Rico Boy, Santa Cruz and the Silver Swan) and nonpoint sources (Columbia tailings and groundwater) of potential concern. The effect of these combined sources to downstream areas is unknown due to the lack of available data.

The recommendations for the Town of Rico as a result of these findings are as follows;

- The Town needs to retain their involvement with ongoing private and CDPHE investigative studies that will fold into regulatory applications (closure of the St. Louis, further mine site study and potential closure, TMDL development).

- A comprehensive watershed-scale monitoring program needs to be developed that characterizes the sub-basin watershed as a whole, and captures more up-gradient and down-gradient areas, as well as other tributaries (such as Horse Creek, Aztec gulch and others) that have known mining areas. There are also mine sites with seeps (Mountain Springs mine etc., which are described in **Sections 6 and 7**) that need further characterization. It is recommended that the Town formulate a field sampling plan for a comprehensive watershed characterization effort, to be completed during high and low flow conditions for years to come. The information will be invaluable in regards to regulatory processes (i.e. TMDL development, Section 208 and 319 requirements) and public information.

- This Section identified the need to fill data gaps (such as those described in the previous bullet) that include the need to characterize sediment. Sediment analysis represents a significant data gap in the understanding of the condition of the *Project area.* Very little information has been gathered to-date in regards to this important medium that can act as a source of contaminant release, be a significant exposure medium to aquatic life, and present a concern to the overall health of the aquatic ecosystem. It is highly recommended that a sediment sampling regime be constructed so as to capture the sediment quality conditions throughout the watershed. This effort should be combined with the comprehensive watershed sampling effort described in the previous bullet, in order to capture co-located water and sediment quality characteristics. This information will be useful in understanding the relationship of water quality to sediment quality.

- The final recommendation is associated with focusing study and potential remedy efforts towards those source areas identified in the water quality characterization. It is possible for the Town to embark upon their own suite of studies, and potentially remedy efforts if desired. There are funding and regulatory resources available to pro-active community efforts. There are numerous examples of successful pro-active projects being completed throughout the State of Colorado, and there is currently legislature being passed that will enable pro-active efforts in the future. It is highly recommended that the Town take a proactive stance in addressing some of the identified source areas contributing metals load to the Silver Creek catchment and the Dolores River.

TABLES

Table 4.1 Agricultural and Domestic Water Supply Water Quality Standards (source; CDPHE, 2002).

Parameter	Agricultural Standards	Domestic Water Supply – Drinking Water Standards
Aluminum (Al)	5 mg/L	
Antimony (Sb)		0.006 mg/L
Arsenic (As)	0.1 mg/L	0.05 mg/L
Barium (Ba)		2.0 mg/L
Beryllium (Be)	0.1 mg/L	0.004 mg/L
Boron (B)	0.75 mg/L	
Cadmium (Cd)	0.01 mg/L	0.005 mg/L
Chromium (Cr)	0.1 mg/L	0.1 mg/L
Cobalt (Co)	0.05 mg/L	
Copper (Cu)	0.2 mg/L	1 mg/L
Cyanide [Free] (CN)		0.2 mg/L
Iron (Fe)	5 mg/L	0.3 mg/L
Fluoride (F)	2 mg/L	4.0 mg/L
Lead (Pb)	0.1 mg/L	0.05 mg/L
Manganese	0.2 mg/L	0.05 mg/L
Mercury [Inorganic] (Hg)	0.01 mg/L	0.002 mg/L
Nickel (Ni)	0.2 mg/L	0.1 mg/L
Nitrate (NO3)	100 mg/L as N	10.0 mg/L as N
Nitrite (NO2)	10 mg/L as N	1.0 mg/L as N
Selenium (Se)	0.02 mg/L	0.05 mg/L
Silver (Ag)		0.05 mg/L
Vanadium (V)	0.1 mg/L	
Thallium (Tl)	2 mg/L	0.002 mg/L
Zinc (Zn)		5 mg/L

Table 4.2. Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 1/3.

Segment and Desig.	Classifications	Numeric Standards: Physical and Biological	Inorganic (mg/l)		Metals (ug/L)		
1. OW	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
2.	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac/ch)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
3.	Aq Life Cold 1 Recreation 1a Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=100(Trec) Cd(ac)=TVS Cd(ch)=TVS CrIII(ch)=100(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
4.	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
5	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS

Table 4.2 Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 2/3.

Segment and Desig.	Classifications	Numeric Standards: Physical and Biological	Inorganic (mg/l)		Metals (ug/L)		
6	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
7	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
8	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
9	Aq Life Cold 2 Agriculture Nov. 1 to April 30, 2006 Recreation 2 May 1 to Oct. 31 Recreation 1a	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 Nov. 1 to April 30 F. Coli = 2000/100ml E. Coli = 630/100ml May 1 to Oct. 31 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ac)=100(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=100(Trec) CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) **Zn(ac/ch)=TVS**

Table 4.2 Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 3/3.

Footnotes

Segment Description

1. All tributaries to the Dolores River and West Dolores River, including all wetlands, tributaries, lakes, and reservoirs, which are within the Lizard Head Wilderness area.
2. Mainstem of the Dolores River from the source to a point immediately above the confluence with Horse Creek.
3. Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek.
4. Mainstem of the Dolores River from a point immediately above the confluence with Bear Creek to the bridge at Bradfield Ranch (Forest Route 505, near Montezuma/Dolores County Line) includes McPhee Reservoir and Summit Reservoir.
5. All tributaries to the Dolores River and West Dolores River, including all wetlands, lakes and reservoirs, from the source to a point immediately below the confluence with the
   West Dolores River except for specific listings in Segments 1 and 6.
6. Mainstem of the Slate Creek and Coke Oven Creek, from their sources to their confluences with the Dolores River.
7. Mainstem of Coal Creek from the boundary of the Lizard Head Wilderness Area to the confluence with the Dolores River.
8. Mainstem of Horse Creek from the source to the confluence with the Dolores River
9. Mainstem of Silver Creek from a point immediately below the Town of Rico's water supply diversion to the confluence with the Dolores River.

BOLD – There is a temporary modification for this reach: An)ch) = 670; with no acute Zn. Expiration date of 12/31/05, in addition to a fish ingestion advisory.

OW - Outstanding Waters

Table 4.3 Table Value Standard Criteria. (source; CWQCC, 2002)		
Parameter	**Table Value Standards**	**Footnotes**
Ammonia	Cold Water Acute = 0.43/FT/FPH/2 in mg/L Warm Water Acute = 0.62/FT/FPH/2 in mg/L	Assumed variable values provided in CDPHE WQCC, 2002.
Cadmium	Acute = (1.13667-[(ln hardness)*(0.04184)])*$e^{(1.128[\ln(hardness)]-3.6867)}$ Acute(Trout) = (1.13667-[(ln hardness)*(0.04184)])*$e^{(1.128[\ln(hardness)]-3.828)}$ Chronic = (1.10167-[(ln hardness)*(0.04184)])*$e^{(0.7852[\ln(hardness)]-2.715)}$	
Chromium III	Acute = $e^{(0.819\ln(hardness)]+2.5736)}$ Chronic = $e^{(0.819[\ln(hardness)]+0.5340)}$	Unless the stability of the chromium valence state in receiving waters can be clearly demonstrated, the standard for chromium should be in terms of chromium VI.
Chromium VI	Acute = 16 Chronic = 11	
Copper	Acute = $e^{(0.9422\ln(hardness)]-1.7408)}$ Chronic = $e^{(0.8454[\ln(hardness)]-1.7428)}$	
Lead	Acute = (1.46203-[(ln hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-1.46)}$ Chronic = (1.46203-[(ln hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-4.705)}$	
Manganese	Acute = $e^{(0.3331\ln(hardness)]+6.4676)}$ Chronic = $e^{(0.3331[\ln(hardness)]+5.8743)}$	
Nickel	Acute = $e^{(0.846\ln(hardness)]+2.253)}$ Chronic = $e^{(0.846[\ln(hardness)]+0.0554)}$	
Selenium	Acute = 18.4 Chronic = 4.6	Selenium is a bioaccumulative metal and subject to a range of toxicity values depending upon numerous site-specific variables.
Silver	Acute = 1/2$e^{(1.72[\ln(hardness)]-6.52)}$ Chronic = $e^{(1.72[\ln(hardness)]-9.06)}$ Chronic(Trout) = $e^{(1.72[\ln(hardness)]-10.51)}$	
Uranium	Acute = $e^{(1.1021[\ln(hardness)]+2.7088)}$ Chronic = $e^{(1.1021[\ln(hardness)]+2.2382)}$	
Zinc	Acute = $e^{(0.8473[\ln(hardness)]+0.8618)}$ Chronic = $e^{(0.8473[\ln(hardness)]+0.8699)}$	

Table 4.4 Water Quality Criteria Adjustments to Pertinent Project Area River Segments as per the CWQCC Triennial Hearing Results. (source; CDPHE CWQCC, 2006).		
River Segment	**Parameter Affected**	**2006 CWQCC Triennial Adjustment**
All	Cadmium – Table Value Standard.	Revised hardness-based algorithms as follows: Acute = $(1.136672-[\ln(hardness) \times (0.041838)] \times e^{0.9151[\ln(hardness)]-3.1485}$ Acute trout = $(1.136672-[\ln(hardness) \times (0.041838)] \times e^{0.9151[\ln(hardness)]-3.1485}$ Chronic = $(1.101672-[\ln(hardness) \times (0.041838)] \times e^{0.7998[\ln(hardness)]-4.4451}$
All	Zinc – Table Value Standard	Acute = $0.978\ e^{(0.8525[\ln(hardness)]+1.0617)}$ Chronic = $0.986\ e^{(0.8525[\ln(hardness)]+0.9109)}$ If hardness is less than 113 mg/L CaCO3, then Chronic (sculpin) = $e^{(2.227[\ln(hardness)]-5.604)}$
Segment 3	Metals	Arsenic acute = 340 Arsenic chronic = 7.6
Segment 9	Metals	Arsenic acute = 340 Arsenic chronic = 7.6 Temporary modification for zinc was eliminated and replaced by the new Zinc – chronic (sculpin) table value standard.

Table 4.5 TMDL Listed Segments Relevant to the Project Area. (source; CDPHE, 2002).					
WBID	Segment Description	Portion	Parameters	Proposed Priority	Basis
COSJDO04[1]	Dolores River, Bear Creek to Bradfield Bridge	McPhee Reservoir	Hg	High	Hg Fish Consumption Advisory
COSJDO05	Tributaries to Dolores River and West Dolores River	Silver Creek above Rico drinking water diversion	Cd, Zn	High	No new data, 1998 303(d) List
COSJDO09	Silver Creek from Rico's diversion to Dolores River	All	Zn	High	Zn amb=668 ug/L, n=26, std=232 ug/L @ 222 mg/L hardness, WQCD 10780 [2]

Footnotes:

WBID :Water Body Identification Number. This number is assigned by the WQCD and is used to group and identify water bodies with the same classifications and standards. The WBID system is the primary way the WQCD identifies and segregates differing water bodies (streams, lakes, and wetlands) from each other in the State of Colorado. Within the 8-10 character alpha-numeric WBID are included the state, major river basin (Arkansas, Rio Grande, Colorado etc..), minor river basin, and segment number. Example: COARUA01A = Colorado, Arkansas Basin, Upper Arkansas River Basin Segment # 1A. For the purposes of this project area, there are two TMDL segments within the project area;

- ✓ COSJDO05 = Colorado, San Juan River Basin, Dolores River, segment 05, and
- ✓ COSJDO09 = Colorado, San Juan River Basin, Dolores River, segment 09.

There is one segment outside of the project area[1], downstream;

- ✓ COSJDO04 = Colorado, San Juan River Basin, Dolores River, segment 04.

Segment Description: Describes the location and extent of the segment.
Portion : Describes the portion of the segment that is impaired or impacted.
Parameters : Identifies the assigned classified use and/or specific parameter for which the waterbody does not attain standards.
Priority Level: Indicates the proposed priority for TMDL completion as either "high", "medium", or "low".
Basis : Indicates the reason the segment was included in the List. Most listings are due to non-attainment of one or more parameter-specific numeric standards. In regards to the COSJDO09 segment, the basis is due to the water quality within Silver creek as having an ambient zinc concentration of 668 ug/L, measured from a dataset with 26 samples. This measured value exceeds the derived ambient water quality criteria of 232 ug/L (using a site-derived hardness of 222 mg/L and the WQCD rules presented in document number 10780) which indicates a concern in regards to the protected value of aquatic life within this drainage.

Table 4.6 ARCO Prepared VCUPs/NADs and their Status. (source; Matrix Design Group, 2004)					
Site Name	**Location**	**VCUP or NAD**	**Description of VCUP or NAD Activity**	**Approval or Withdrawn**	**Date of VCUP Completion Report**
ARCO: Columbia Tails I	West of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Columbia Tails II	West of Rico	VCUP	Inhibit water infiltration and create drainage controls + revegetate.	Approval	9/17/1999
ARCO; Grandview Smelter I	North of Rico	VCUP	Inhibit water infiltration and create drainage controls + revegetate.	Approval	1/1997
ARCO: Grandview Smetlter II	North of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Santa Cruz I	West of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Approval	1/1997
ARCO; Santa Cruz II	West of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Silver Swan I	Southwest of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Withdrawn	
ARCO; Silver Swan II	Southwest of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Approval	1/1997
ARCO; Silver Swan III	Southwest of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO: Agentine Tails I	Northeast of Rico	VCUP	Consolidation of dispersed tails + cap.	Withdrawn	
ARCO; Argentine Tails II	Northeast of Rico	VCUP	Consolidation of dispersed tails + cap.	Approval	1/1997
ARCO: Argentine Tails III	Northeast of Rico	NAD	No Action Petition	Approval	12/10/1999

Table 4.7 Available Zinc Assimilative Capacities and Zinc Contributions – Provided by CDPHE (2001). (as cited in Matrix Design Group, 2004).	
Maximum Assimilative Loading, Background and Facility Contributions at the 85th percentile.	**Loading in pounds (lbs/day)**
Acute Maximum Assimilative Loading	4.95
Background Allocation	-0.95
St. Louis Ponds Point Source Contribution	-17.81
Blaine Adit Point Source Contribution	-8.01
Argentine Seep Point Source Contribution	-3.75
Columbia Tailings seep Point Source Contribution	-4.81
Rico Boy Adit Point Source Contribution	-0.39
Santa Cruz Adit Point Source Contribution	-0.35
Silver Swan Adit Point Source Contribution	-0.48
Deficit	-31.60

Table 4.8 Summary of USGS Sample Information for the Project Area. (sources; USGS, 2006a and 2006b).							
			Available Data (# of samples)				
Site Number	Site Name	Lat. & Long.	Years (From – To)	Nutrients(1)	Major Inorganics(2)	Trace Inorganics(3)	Physical Properties(4)
Water Quality Sites							
09165000	Dolores River below Rico	37°38'20" 108°03'35"	1959 - 2004	2	3	3	438
374052108020700	Silver Swan Mine at Rico	37°40'52" 108°02'07"	1975	1	1	1	1
374228108013900	St Louis Tunnel at Rico	37°42'28" 108°01'39"	1975	1	1	1	1
374202108003300	Blaine Tunnel at Rico	37°42'02" 108°00'33"	1975	1	1	1	1
374645107563400	Dolores River above Snow Spur Creek, near Coke Oven	37°46'45" 107°56'34"	1971	-	1	1	1
374608107584800	Barlow Creek at mouth near Coke Oven	37°46'08" 107°58'48"	1971	-	-	1	1
Ground Water Sites							
374212108014201 NB04001125	Dolores County, HUC 1403002	37°49'36" 108°43'00"	1973 - 1983	-	-	-	5
374242108020501 NB04001123DDA1	Spring	37°42'12" 108°03'35"	-	-	-	-	-
374241108021501 NB04001126AAB	Dolores County	37°51'06" 108°17'28"	1982	-	-	-	2

Parameters by Category
(1) Nutrients – Nitratie plus nitrite, orthophosphate and phosphorous
(2) Major Inorganics – Calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride and Silica
(3) Trace Inorganics – Arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, silver, zinc, selenium.
(4) Physical Properties: Flow/discharge, depth to water, temperature, specific conductance, pH

Table 4.9 Geothermal Springs Water Quality in 1995. (source; URS/USEPA, 1996).				
Location	Water Temp (oF)	pH	Conductivity (uS/cm)	Flow (gal/min)
Hot Tub Spring	107.9	6.60	7,280	30-50
2nd Hot Spring	107.3	6.66	7,080	15-20

Table 4.10 Summary of CGS Abandoned Mine Lands Ranking of Sites within the Project Area. (source; CGS, 1989). Pg. 1 of 2.

Priority Ranking*	Site	Features Associated with the Site	Feature EDR Value	Feature PHR Value
1	Mountain Spring Mine	Mine Shaft	2 (completely flooded and releasing 30 gpm of degraded water)	2
		85,000 yd^3 dump	1 (associated with shaft flows, reaches the Dolores River)	
		800 yd^3	3 (effluent from shaft crosses the top of the pile)	
		2,500 yd^3	3 (presence of sulfides)	
2	Nora Lily Mine	Open/barricaded adit	2 (degraded water quality, close proximity to Dolores River)	na
		70 yd^3 dump	2 (acid generating)	
		150 yd^3 dump	3 (potential acid generation)	
		350 yd^3 dump	3 (potential acid generation)	
4	Revenue Mine Area	350 yd^3	2 (suspected mill tailings with pyrite exhibiting phytotoxicity)	2
		750 yd^3 dump	3 (high concentrations of sulfide materials)	
		1,750 yd^3 dump	3 (high sulfide content, seep that communicates with gw → Silver Creek)	
		1,900 yd^3 dump	3 (0.5 gpm seep, high sulfide content)	
5	ABG Mine	10,000 yd^3 dumo	2 (precipitates present, located within riparian, has a small seep)	na
		Collapsed Adit	3 (28 gpm with yellow – orange precipitate)	
6	Johnny Bull Mtn.	350 yd^3 dump	2 (significantly degraded water quality and presence of oxidized drainage channels)	na
		Collapsed Adit	3 (degraded water quality parameters and presence of oxidized drainage channels)	
7	West End of Horse Gulch	Caved Adit	3 (thick, orange precipitate)	na
		Caved Adit	3 (orange precipitate)	

Tabl 4.10 Cont.. Summary of CGS Abandoned Mine Lands Ranking of Sites within the Project Area. (source; CGS, 1989). Pg. 2 of 2.

Priority Ranking*	Site	Features Associated with the Site	Feature EDR Value	Feature PHR Value
8	Aztec Mine and Gulch	Caved Adit	3 (degraded water quality and associated mine dump)	na
		Caved Mine	3 (extremely high concentrations of zinc)	
		1,500 yd^3 dump	3 (associated with Aztec Gulch)	
		Caved Adit	3 (degraded water quality)	
		950 yd^3 dump	3 (specular hematite, pyrite, malachite and manganese oxides)	
9	Middle CHC Hill	50,000 yd^3 dump	3 (uphill of Mtn. Spring, likely connected underground)	na
		750 yd^3 dump	3 (dump agregate, high sulfide content)	
11	North of Horse Creek	Collapsed Adit	3 (degraded water quality)	2
		Caved Adit	3 (75 gpm effluent with degraded water quality)	
		Caved Adit	3 (20 gpm effluent, communicates with lower adit)	
		Caved Adit	3 (10 gpm effluent, phytotoxicity on associated pile)	
12	Sambo Mine Area	Caved adit	3 (10 gpm of flow, contains precipitates)	2
		Partially caved adit	3 (< 1gpm flow)	
13	South of Aztec Gulch – North of Bemis Flats	Caved adit	3 (elevated zinc and manganese concentrations)	2
15	Bridgehead Mines	Adit	3 (1 gpm effluent with degraded water quality, affects down-gradient water quality)	na

Table 4.11 Analytical Data for Samples Collected from the Horse Creek Sub-basin by CGS. (source; Neubert, 2000).						
Parameter	NW-80 Horse Creek		NW-81 Horse Creek South		NW-82 Darling Ridge North	
	Conc./Meas. (and load in gms/day)	Standard	Conc./Meas. (and load in gms/day)	Standard	Conc./Meas.(and load in gms/day)	Standard
Flow (gpm)	150	n/a	100.0	n/a	23.0	n/a
pH	7.86	n/a	4.18	n/a	7.12	n/a
Conductivity (uS/cm)	198.0	n/a	298.0	n/a	449.0	n/a
Alkalinity (mg/L $CaCO_3$)	50.00	n/a	-	n/a	22.0	n/a
Hardness (mg/L $CaCO_3$)	191	None	159	None	399	None
Aluminum (trec) ug/L	<50	None	2,700 (1,471.8)	None	2,300 (288.4)	None
Antimony (trec) ug/L	<1.0	6.00	<1.0	6.00	<1.0	6.00
Arsenic (trec) ug/L	<1.0	50.00	<1.0	50.00	<1.0	50.00
Iron (trec) ug/L	15 (12.3)	1,000.00	400 (218)	1,000.00	830 (104.1)	1,000.00
Thallium (trec) ug/L	<1.0	0.50	<1.0	0.50	<1.0	0.50
Zinc (trec) ug/L	11 (9.0)	2,000.00	360 (196.2)	2,000.00	270 (33.0)	2,000.00
Aluminum (diss) ug/L	<50	87.00	2,700 (1,471.8)	87.00	<50	87.00
Cadmium (diss) ug/L	<0.3	1.88	2.9 (1.6)	1.64	2.2	3.36
Calcium mg/L	68 (55,600.2)	None	51 (27,800.1)	None	140 (17,552.2)	None
Chloride mg/L	<20.0	250.00	<20.0	250.00	<20	250.00
Chromium (diss) ug/L	<10.0	11.00	<10.0	11.00	<10	11.00
Copper (diss) ug/L	<4.0	20.51	160.0 (87.2)	17.62	6.0 (0.8)	38.59
Fluoride mg/L	0.26 (212.60)	2.00	0.65 (354.3)	2.00	0.57 (71.5)	2.00
Iron (diss) ug/L	<10	300.00	380 (207.1)	300.00	130 (16.3)	300.00
Lead (diss) ug/L	<1.0	9.70	<1.0	7.54	<1.0	27.66
Magnesium mg/L	5.00 (4,088.3)	None	7.80 (4,251.8)	None	12.00 (1,504.5)	None
Manganese (diss) ug/L	<4	50.00	3,600 (1,962.4)	50.00	2,500 (313.4)	50.00
Nickel (diss) ug/L	<20	155.98	<20	136.27	<20	273.69
Potassium mg/L	<1.0	None	1.3 (708.6)	None	1.2 (150.4)	None
Silicon mg/L	1.3 (1,062.9)	None	14.0 (7,631.4)	None	8.4 (1,053.1)	None
Silver (diss) ug/L	<0.2	0.23	<0.2	0.17	<0.2	0.81
Sodium mg/L	0.69 (564.2)	None	3.4 (1,853.3)	None	2.50 (313.4)	None
Sulfate mg/L	42 (34,341.3)	250.00	120 (6,5412.0)	250.00	190 (23,820.9)	250.00
Zinc (diss) ug/L	<10	182.99	390 (212.6)	157.41	200 (25.1)	342.50

Table 4.12 Summary of Available Data for Locations withinSilver Creek.									
Year	Analysis Completed by Location and Year (source: SEH, 2002)								
	SVS-1	SVS-1T	SC-2	SVS-22	SVS-12	SVS-8	SVS-5	SVS-26	SVS-20
1980	M, Cl, N, Wq	–	–	–	–	–	–	–	–
1981	M, Cl, N, Wq	–	–	–	–	–	F	–	F
1982	M, Cl, N, Wq	–	–	–	–	–	F	–	F
1983	M, Cl, Wq	–	–	–	–	F	–	–	F
1984	M, Cl, Wq	–	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–
1988	–	–	–	–	–	–	–	–	–
1989	–	–	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–	–	–
1991	–	–	–	–	–	–	–	–	–
1992	M, Cl	–	–	–	–	F	–	–	F
1993	–	–	–	–	–	–	–	–	F
1994	–	–	–	–	–	–	–	–	–
1995	–	–	–	–	–	F	F	–	–
1996	–	–	–	–	–	F	F	–	–
1997	–	–	–	–	M, Wq	M, Wq	M, Wq	–	M, Wq
1998	–	–	–	–	–	–	F, M, Wq	–	M, Wq
1999	M, Wq	–	M, Wq	–	–	–	M, Wq	–	F, M, Wq
2000	F, M, Wq	–	F, M, Wq	–	–	–	M, Wq	–	–
2001	–	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	–	F, M, Wq
2002	–	F, M, Wq	–	F, M, Wq	F, Hg, M, Wq	F, M, Wq	–	F, Hg, M, Wq	F, Hg, M, Wq
2003	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	M, Wq
2004	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	M, Wq
2005	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***
2006	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***

Locations:

SVS-1 - Silver Creek, just below Town of Rico Water Supply Diversion
SVS-1T - Silver Creek, above Town of Rico Water Supply Diversion
SC-2 Blaine Adit Discharge
SVS-22 - Silver Creek, just upstream of Argentine Tailings Seep
SVS-12 - Argentine Tailings Seep
SVS-8 - Silver Creek, below Argentine tailings, just below culvert outfall
SVS-5 Below Blaine Tunnel
SVS-26 - Tramway discharge on Silver Creek
SVS-20 - Silver Creek, just above confluence with Dolores River

Footnotes:

– No analysis completed
F - Flow
Hg - Mercury
M - Metals - Inorganic constituents such as Cd, Cu, Mn, Zn and others. The list of analyzed constituents varies by location and year.
Cl - Common ions such as sulfate, phosphate and others
N - nutrients such as nitrogen (measured by nitrate and nitrite), phosphororus
Wq - Water quality - includes measures of hardness, pH, Total suspended solids, total organic carbon and others.
uk - the suite of analysis to be completed by SEH is unknown.

Table 4.13 Summary of Available Data for Locations within the Dolores River.

Year	Above	St. Louis Tunnel Pond System			Dolores River up- and down-stream of 002		Below Bridge	Columbia Tailings Area		Santa Cruz/Rico Boy Area						Silver Swan Area			USGS Gauge
	DR-1	DR-3	DR-6	DR-20	DR-2	DR-7	DR-2-SW	DR-1-SW	DR-26	DR-27	DR-9-SW	DR-10-SW	DR-8-SW	DR-16-SW	DR-18	DR-7-SW	DR-6-SW	DR-4-SW	DRG
1980	F	F	F	F	–	F	F	–	–	–	–	–	F	F	–	–	–	–	F
1981	F	F	F	F	F	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1982	F	F	F	–	–	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1983	F	F	F	F	–	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1984	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1985	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1986	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1987	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1988	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1989	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1990	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1991	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1992	F	–	F	–	–	F	–	–	–	–	–	–	–	F	–	F	–	–	F
1993	F	–	F	–	–	F	F	–	–	–	–	–	–	–	–	–	–	F	F
1994	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1995	–	F	–	–	–	–	F	–	–	–	–	–	F	F	–	F	–	F	F
1996	–	–	–	–	–	–	F	–	–	–	–	–	F	F	F	F	–	–	F
1997	–	–	–	–	–	–	M, Wq	F, M, Wq	–	–	M, Wq	–	F, M, Wq	M, Wq	M, Wq	F, M, Wq	M, Wq	M, Wq	F
1998	M, Wq	–	–	–	–	M, Wq	F, M, Wq	F, M, Wq	–	–	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	M, Wq	M, Wq	F
1999	M, Wq	M, Wq	M, Wq	–	M, Wq	M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2000	F, M, Wq	M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2001	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2002	F, Hg, M, Wq	F, Hg, M, Wq	F, Hg, M, Wq	M, Wq	F, M, Wq	F, Hg, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, Hg, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	–	F, Hg, M, Wq	F, M
2003	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	F	F, M, Wq	F, M
2004	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	–	F, M, Wq	F, M
2005	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*
2006	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*

Locations:

DR-1 - Dolores River, above St. Louis Ponds
DR-3 - Tunnel Discharge
DR-6 - St. Louis Ponds 002 Discharge
DR-1 - Dolores River above St. Louis Ponds
DR-20 - Dolores River west of Pond 14
DR-2 - Dolores River, just upstream of 002 discharge
DR-7 - Dolores River, Downstream of 002 discharge
DR-2-SW - Dolores River, just Downstream of bridge
DR-1-SW - Dolores River side channel / Columbia Tailings seep
DR-26 - Dolores River between Columbia tailings seep and Rico Boy/Santa Cruz wetlands
DR-9-SW - Santa Cruz / Rico Boy Wetlands, east discharge
DR-10-SW - Santa Cruz / Rico Boy Wetlands, west discharge
DR-7-SW - Silver Swan Adit Discharge
DR-26 - Dolores River, between Columbia Tailings seep and Santa Cruz Wetlands
DR-27 - Santa Cruz / Rico Boy combined adit discharge
DR-6-SW - Silver Swan Wetlands Discharge
DR-4-SW - Dolores River downstream of Silver Swan
DR-8-SW - Santa Cruz Adit
DR-16-SW - Rico Boy Adit
DR-18-SW - Dolores River between Santa Cruz and Silver Swan
DRG - USGS Gauging Station below Rico

Footnotes:

– No analysis completed
F - Flow
Hg - Mercury
M - Metals - Inorganic constituents such as Cd, Cu, Mn, Zn and others. The list of analyzed constituents varies by location and year.
Cl - Common ions such as sulfate, phosphate and others
N - nutrients such as nitrogen (measured by nitrate and nitrite), phosphororus
Wq - Water quality - includes measures of hardness, pH, Total suspended solids, total organic carbon and others.
uk - the suite of analysis to be completed by SEH is unknown.

Table 4.14 2002 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
July 18-19, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	1.70	7.60	0	u	7.60	uk
	Cadmium (d)	13.00	9.80	1	u	11.52	uk
	Chromium (t)	9.80	382.63	0	1.60	458.34	0
	Copper (d)	20.00	88.64	0	3.00	109.10	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	13900.00	1000.00	14	390.00	1000.00	0
	Lead (d)	16.70	20.36	1	u	25.22	uk
	Manganese (d)	2050	3216	1	505	3461	0
	Mercury (t)	u	0.01	uk	na	0.01	uk
	Nickel (d)	u	283.41	uk	u	341.52	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk
	Silver (d)	u	10.06	uk	u	14.69	uk
	Zinc (d)	3430.00	686.27	5	410.00	828.15	0
	Hardness mg/L	742			925		
October 6-9, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	2.10	7.60	0	u	7.60	uk
	Cadmium (d)	13.80	9.99	1	1.70	10.81	0
	Chromium (t)	u	391.05	uk	u	426.84	uk
	Copper (d)	30.00	90.88	0	u	100.52	uk
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	12000.00	1000.00	12	300.00	1000.00	0
	Lead (d)	13.20	20.90	1	u	23.19	uk
	Manganese (d)	1830	3245	1	296	3362	0
	Mercury (t)	0.00	0.01	0	0.00	0.01	0
	Nickel (d)	10.00	289.86	0	u	317.31	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk
	Silver (d)	0.18	10.53	0	u	12.65	uk
	Zinc (d)	2970.00	702.01	4	400.00	769.01	1
	Hardness mg/L	762			848		

Std. - water quality standard
HQ - hazard quotient
u - undetected
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.15 2003 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	28.40	9.68	3	4.60	11.34	0
	Chromium (t)	0.80	377.55	0	0.10	450.20	0
	Copper (d)	20.60	87.28	0	6.40	106.87	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk
	Iron (t)	11600.00	1000.00	12	290.00	1000.00	0
	Lead (d)	17.40	20.04	1	0.60	24.69	0
	Manganese (d)	2170	3199	1	685	3436	0
	Mercury (t)	u	0.01	uk	0.0003	0.01	0
	Nickel (d)	u	279.53	uk	10.00	335.26	0
	Selenium (d)	0.20	4.60	0	0.90	4.60	0
	Silver (d)	u	9.78	uk	0.80	14.15	0
	Zinc (d)	5190.00	676.80	8	1120.00	812.87	1
	Hardness mg/L	730			905		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.16 2004 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	19.96	6.22	3	7.73	6.22	1
	Chromium (t)	u	230.67	uk	u	230.67	uk
	Copper (d)	27.30	49.52	1	9.50	49.52	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk
	Iron (t)	3200.00	1000.00	3	302.00	1000.00	0
	Lead (d)	u	10.94	uk	u	10.94	uk
	Manganese (d)	1830	2618	1	1070	2618	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	u	168.04	uk	u	168.04	uk
	Selenium (d)	u	4.60	uk	1.39	4.60	0
	Silver (d)	u	3.47	uk	u	3.47	uk
	Zinc (d)	4180.00	405.26	10	1690.00	405.26	4
	Hardness mg/L	738			817		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	0.80	7.60	0	nd	7.60	uk
	Cadmium (d)	24.50	6.22	4	15.00	6.22	2
	Chromium (t)	0.50	230.67	0	u	230.67	uk
	Copper (d)	18.50	49.52	0	7.60	49.52	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	11000.00	1000.00	11	1370.00	1000.00	1
	Lead (d)	u	10.94	uk	0.20	10.94	0
	Manganese (d)	2230	2618	1	2080	2618	1
	Mercury (t)	u	0.01	uk	u	0.01	uk
	Nickel (d)	u	168.04	uk	u	168.04	uk
	Selenium (d)	3.00	4.60	1	u	4.60	uk
	Silver (d)	u	3.47	uk	0.06	3.47	0
	Zinc (d)	4200.00	405.26	10	3140.00	405.26	8
	Hardness mg/L	680			732		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.17 2002 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.

Sampling Timeline	Metals (ug/L)	SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
July 18-19, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	nd	7.60	0	0.80	7.60	0	nd	7.60	0	u	7.60	uk	nd	7.60	0
	Cadmium (d)	4.00	2.73	1	4.00	9.21	0	3.00	3.44	1	16.00	6.06	3	4.00	3.97	1
	Chromium (t)	u	92.46	uk	u	357.09	uk	0.10	119.40	0	u	224.04	uk	u	139.79	uk
	Copper (d)	2.00	17.30	0	2.00	81.87	0	2.00	23.21	0	51.00	47.88	1	2.00	27.83	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	u	-	na	5780.00	-	na	90.00	-	na	14800.00	-	na	10.00	-	na
	Lead (d)	0.50	3.37	0	1.70	18.74	0	u	4.71	uk	40.70	10.55	4	0.50	5.78	0
	Manganese (d)	u	1805	uk	7200	3127	2	648	2003	0	10800	2587	4	12	2135	0
	Mercury (t)	u	0.01	uk	u	0.01	uk	nd	0.01	0	nd	0.01	0	u	0.01	uk
	Nickel (d)	u	65.35	uk	20.00	263.90	0	u	85.11	uk	u	163.05	uk	u	100.16	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.12	uk	u	2.04	uk	u	0.20	uk	u	0.77	uk	u	0.28	uk
	Zinc (d)	420.00	156.48	3	6110.00	638.67	10	940.00	204.19	5	8050.00	393.13	20	470.00	240.61	2
	Hardness mg/L	131			682			179			386			217		
October 6-9, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	nd	7.60	uk	u	7.60	uk	nd	7.60	uk	u	7.60	uk	u	7.60	uk
	Cadmium (d)	1.20	2.93	0	0.80	9.89	0	1.20	5.39	0	11.50	6.26	2	1.50	5.66	0
	Chromium (t)	u	99.91	uk	u	386.42	uk	u	196.56	uk	u	232.09	uk	u	207.75	uk
	Copper (d)	u	18.91	uk	u	89.65	uk	u	41.19	uk	70.00	49.87	1	u	43.90	uk
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	80.00	-	na	4720.00	-	na	130.00	-	na	15200.00	-	na	20.00	-	na
	Lead (d)	1.00	3.73	0	u	20.60	uk	0.50	8.95	0	u	11.03	uk	0.30	9.59	0
	Manganese (d)	12	1863	0	5760	3229	2	269	2453	0	11400	2624	4	56	2509	0
	Mercury (t)	nd	0.01	uk	u	0.01	uk	nd	0.01	na	0.0006	0.01	0	0.0003	0.01	0
	Nickel (d)	u	70.80	uk	10.00	286.32	0	u	142.43	uk	30.00	169.10	0	u	150.81	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.14	uk	u	2.41	uk	u	0.58	uk	0.08	0.83	0	u	0.65	uk
	Zinc (d)	290.00	169.62	2	5070.00	693.36	7	490.00	343.07	1	8120.00	407.85	20	390.00	363.42	1
	Hardness mg/L	144			751			329			403			352		

Std. - water quality standard

HQ - hazard quotient

u - undetected

nd - no existing data for the analyte at this site during this sampling event

- no set standard

HQ 2-10 indicates an uncertain potential for risk

HQ >10 indicates the potential for risk and the need for further evaluation

uk - unknown HQ value

na - HQ value does not apply because there is no set standard

Table 4.18 2003 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.																						
Sampling Timeline	Metals (ug/L)	SVS-1T			SVS-1			SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.56	uk	u	2.65	uk	2.20	3.06	1	0.40	9.31	0	1.60	3.14	1	9.70	6.58	1	1.60	3.86	0
	Chromium (t)	u	86.05	uk	0.10	89.56	0	0.40	105.00	0	0.20	361.38	0	0.20	107.80	0	0.10	245.68	0	0.20	135.55	0
	Copper (d)	0.60	15.93	0	0.80	16.68	0	3.10	20.02	0	6.10	83.00	0	3.00	20.64	0	187.00	53.24	4	2.60	26.86	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	u	-	na	u	-	na	350.00	-	na	3830.00	-	na	50.00	-	na	16300.00	-	na	20.00	-	na
	Lead (d)	u	3.07	uk	u	3.23	uk	0.30	3.99	0	u	19.01	uk	0.30	4.13	0	0.50	11.84	0	0.30	5.56	0
	Manganese (d)	u	1753	uk	u	1782	uk	59	1901	0	6480	3142	2	149	1921	0	9460	2686	4	48	2109	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0004	0.01	0	0.0009	0.01	0
	Nickel (d)	nd	60.68	uk	nd	63.24	uk	nd	74.53	uk	nd	267.17	uk	nd	76.58	uk	nd	179.34	uk	nd	97.03	uk
	Selenium (d)	0.10	4.60	0	0.20	4.60	0	0.10	4.60	0	nd	4.60	uk	nd	4.60	uk	u	4.60	uk	0.30	4.60	0
	Silver (d)	u	0.10	uk	u	0.11	uk	u	0.16	uk	nd	2.09	uk	nd	0.16	uk	u	0.93	uk	u	0.27	uk
	Zinc (d)	u	145.20	uk	30.00	151.37	0	640.00	178.62	4	nd	646.65	uk	nd	183.58	uk	6530.00	432.74	15	560.00	233.02	2
	Hardness mg/L	120			126			153			692			158			432			209		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
- no set standard
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value
na - HQ value does not apply because there is no set standard

Table 4.19 2004 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.

Sampling Timeline	Metals (ug/L)	SVS-1T			SVS-1			SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	nd	hard nd	uk	u	2.05	uk	2.16	2.34	1	1.74	12.01	0	2.32	2.65	1	10.52	6.08	2	3.05	3.48	1
	Chromium (t)	nd	hard nd	uk	u	67.37	uk	u	77.74	uk	u	480.14	uk	u	89.56	uk	0.40	224.99	0	u	121.04	uk
	Copper (d)	nd	hard nd	uk	2.95	12.02	0	7.10	14.17	1	4.70	115.09	0	5.15	16.68	0	509.00	48.12	11	7.10	23.58	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	nd	-	na	22.60	-	na	480.00	-	na	3720.00	-	na	504.00	-	na	16100.00	-	na	304.00	-	na
	Lead (d)	nd	hard nd	uk	0.204	2.22	0	0.20	2.68	0	0.70	26.63	0	0.10	3.23	0	3.74	10.61	0	0.41	4.80	0
	Manganese (d)	nd	hard nd	uk	u	1587	uk	81	1682	0	8340	3527	2	116	1782	0	9430	2591	4	86	2014	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	nd	hard nd	uk	nd	47.12	uk	nd	54.63	uk	nd	358.31	uk	nd	63.24	uk	nd	163.76	uk	nd	86.31	uk
	Selenium (d)	nd	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	0.95	4.60	0
	Silver (d)	nd	hard nd	uk	u	0.06	uk	u	0.08	uk	u	3.80	uk	u	0.11	uk	u	0.77	uk	u	0.21	uk
	Zinc (d)	nd	hard nd	uk	18.40	112.55	0	424.00	130.63	3	6140.00	869.20	7	433.00	151.37	3	5610.00	394.87	14	565.00	207.10	3
	Hardness mg/L	nd			89			106			979			126			388			182		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.30	uk	u	2.05	uk	2.30	2.30	1	0.60	10.00	0	2.30	2.88	1	13.30	5.53	2	2.50	4.28	1
	Chromium (t)	u	76.54	uk	u	67.37	uk	u	76.54	uk	0.10	391.47	0	0.40	98.20	0	u	202.41	uk	u	152.33	uk
	Copper (d)	u	13.92	uk	u	12.02	uk	0.70	13.92	0	2.60	91.00	0	1.00	18.54	0	53.90	42.61	1	1.30	30.72	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	u	-	na	40.00	-	na	160.00	-	na	3600.00	-	na	160.00	-	na	18900.00	-	na	60.00	-	na
	Lead (d)	u	2.63	uk	u	2.22	uk	0.80	2.63	0	u	20.92	uk	0.70	3.65	0	6.70	9.28	1	0.20	6.46	0
	Manganese (d)	u	1671	uk	u	1587	uk	49	1671	0	7140	3246	2	170	1850	0	7800	2482	3	70	2211	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0002	0.01	0	u	0.01	uk
	Nickel (d)	nd	53.76	uk	nd	47.12	uk	nd	53.76	uk	nd	290.19	uk	nd	69.55	uk	nd	146.81	uk	nd	109.46	uk
	Selenium (d)	4.00	4.60	1	2.00	4.60	0	2.00	4.60	0	u	4.60	uk	u	4.60	uk	3.00	4.60	1	1.00	4.60	0
	Silver (d)	u	0.08	uk	u	0.06	uk	u	0.08	uk	u	2.47	uk	u	0.14	uk	u	0.62	uk	u	0.34	uk
	Zinc (d)	u	128.53	uk	u	112.55	uk	450.00	128.53	4	5910.00	702.79	8	570.00	166.60	3	7110.00	353.71	20	730.00	263.11	3
	Hardness mg/L	104			89			104			763			141			341			241		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
\- no set standard
hard nd - no standard calculated because standard is dependent on hardness detection which is nd
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value
na - HQ value does not apply because there is no set standard

Table 4.21 2003 Metals Results as Compared to AWQC using HQ Analysis for Locations along the Dolores River.

Sampling Timeline	Metals (ug/L)	DR-1			DR-20			DR-2			DR-7			DR-2-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.78	uk	nd	hard nd	uk	u	3.68	uk	0.20	4.23	0	0.30	4.15	0
	Chromium (t)	0.10	94.19	0	nd	hard nd	uk	u	128.61	uk	0.20	150.26	0	0.20	147.13	0
	Copper (d)	0.80	17.67	0	nd	hard nd	uk	1.60	25.29	0	2.00	30.24	0	2.40	29.52	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	u	5.00	uk	nd	5.00	uk
	Iron (t)	70.00	1000.00	0	nd	1000.00	uk	80.00	1000.00	0	150.00	1000.00	0	120.00	1000.00	0
	Lead (d)	u	3.46	uk	nd	hard nd	uk	u	5.19	uk	u	6.35	uk	u	6.18	uk
	Manganese (d)	29	1819	0	nd	hard nd	uk	292	2064	0	305	2199	0	276	2180	0
	Mercury (t)	0.0012	0.01	0	nd	0.01	uk	nd	0.01	uk	0.0005	0.01	0	nd	0.01	uk
	Nickel (d)	u	66.62	uk	nd	hard nd	uk	nd	91.90	uk	u	107.92	uk	nd	105.60	uk
	Selenium (d)	0.50	4.60	0	nd	4.60	uk	0.50	4.60	0	0.50	4.60	0	0.50	4.60	0
	Silver (d)	u	0.53	uk	nd	hard nd	uk	u	1.02	uk	u	1.41	uk	u	1.35	uk
	Zinc (d)	10.00	159.53	0	nd	hard nd	uk	u	220.61	uk	40.00	259.39	0	130.00	253.78	1
	Hardness mg/L	134			nd			196			237			231		

Metals (ug/L)	DR-1-SW			DR-26			DR-9-SW			DR-27			DR-7-SW			DR-4-SW		
	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
Cadmium (d)	2.50	4.91	1	0.80	4.61	0	u	6.22	uk	2.00	6.22	0	1.00	6.22	0	0.60	4.54	0
Chromium (t)	0.10	177.26	0	0.20	165.15	0	0.20	230.67	0	0.20	230.67	0	u	230.67	uk	u	162.61	uk
Copper (d)	3.30	36.57	0	0.60	33.72	0	2.20	49.52	0	18.30	49.52	0	4.60	49.52	0	2.60	33.12	0
Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
Iron (t)	1900.00	1000.00	2	210.00	1000.00	0	900.00	1000.00	1	10.00	1000.00	0	7730.00	1000.00	8	170.00	1000.00	0
Lead (d)	u	7.85	uk	0.50	7.17	0	u	10.94	uk	0.20	10.94	0	0.20	10.94	0	0.10	7.03	0
Manganese (d)	416	2352	0	371	2285	0	6480	2618	2	203	2618	0	1810	2618	1	317	2271	0
Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0003	0.01	0	u	0.01	uk
Nickel (d)	nd	128.01	uk	nd	118.99	uk	nd	168.04	uk	nd	168.04	uk	nd	168.04	uk	nd	117.09	uk
Selenium (d)	0.50	4.60	0	0.60	4.60	0	u	4.60	uk	u	4.60	uk	0.30	4.60	0	0.50	4.60	0
Silver (d)	u	2.00	uk	u	1.72	uk	u	3.47	uk	u	3.47	uk	u	3.47	uk	u	1.67	uk
Zinc (d)	1230.00	308.08	4	0.20	286.21	0	70.00	405.26	0	1830.00	405.26	5	840.00	405.26	2	110.00	281.62	0
Hardness mg/L	290			266			426			1000			1090			261		

Std. - water quality standard

HQ - hazard quotient

u - undetected

nd - no existing data for the analyte at this site during this sampling event

hard nd - no standard calculated because standard is dependent on hardness detection which is nd

HQ 2-10 indicates an uncertain potential for risk

uk - unknown HQ value

Table 4.22 2004 Metals Results as Compared to AWQC using HQ Analysis for Locations along the Dolores River.

Sampling Timeline	Metals (ug/L)	DR-1			DR-20			DR-2			DR-7			DR-2-SW			DR-1-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.10	uk	nd	hard nd	uk	0.34	2.69	0	0.13	2.59	0	u	2.22	uk	4.33	5.17	1
	Chromium (t)	u	69.22	uk	nd	hard nd	uk	u	90.72	uk	u	87.23	uk	u	73.51	uk	u	187.71	uk
	Copper (d)	u	12.40	uk	nd	hard nd	uk	4.60	16.92	0	u	16.18	uk	3.60	13.29	0	7.70	39.07	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	u	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	370.00	1000.00	0	nd	1000.00	uk	171.00	1000.00	0	506.00	1000.00	1	310.00	1000.00	0	2900.00	1000.00	3
	Lead (d)	u	2.30	uk*	nd	hard nd	uk	0.12	3.29	0	u	3.12	uk	0.52	2.49	0	0.54	8.44	0
	Manganese (d)	8	1604	0	nd	hard nd	uk	75	1791	0	72	1763	0	46	1644	0	738	2407	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	u	48.46	uk	nd	hard nd	uk	u	64.09	uk	u	61.53	uk	nd	51.57	uk	nd	135.81	uk
	Selenium (d)	u	4.60	uk	nd	4.60	uk	u	4.60	uk	0.81	4.60	0	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.28	uk	nd	hard nd	uk	u	0.49	uk	u	0.45	uk	u	0.31	uk	u	2.25	uk
	Zinc (d)	8.95	115.77	0	nd	hard nd	uk	nd	153.42	uk	29.20	147.26	0	20.00	123.24	0	1570.00	327.00	5
	Hardness mg/L	92			nd			128			122			99			311		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	0.60	7.60	0	0.90	7.60	0	0.90	7.60	0	1.00	7.60	0	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.56	uk	u	2.56	uk	0.10	2.97	0	0.90	3.58	0	0.90	3.86	0	1.60	4.17	0
	Chromium (t)	u	86.05	uk	u	86.05	uk	u	101.61	uk	u	124.83	uk	0.10	135.55	0	u	147.65	uk
	Copper (d)	u	15.93	uk	u	15.93	uk	u	19.28	uk	1.40	24.43	0	1.00	26.86	0	1.10	29.64	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	u	5.00	uk	u	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	70.00	1000.00	0	130.00	1000.00	0	110.00	1000.00	0	290.00	1000.00	0	150.00	1000.00	0	1600.00	1000.00	2
	Lead (d)	u	3.07	uk	0.10	3.07	0	u	3.82	uk	u	5.00	uk	u	5.56	uk	u	6.21	uk
	Manganese (d)	19	1753	0	40	1753	0	150	1875	0	279	2039	0	235	2109	0	414	2183	0
	Mercury (t)	0.0005	0.01	0	0.0005	0.01	0	nd	0.01	uk	0.0003	0.01	0	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	u	60.68	uk	u	60.68	uk	u	72.05	uk	u	89.11	uk	nd	97.03	uk	nd	105.99	uk
	Selenium (d)	1.00	4.60	0	u	4.60	uk	3.00	4.60	1	3.00	4.60	1	2.00	4.60	0	u	4.60	uk
	Silver (d)	u	0.44	uk	u	0.44	uk	u	0.62	uk	u	0.96	uk	u	1.14	uk	u	1.36	uk
	Zinc (d)	u	145.20	uk	u	145.20	uk	u	172.63	uk	170.00	213.87	1	180.00	233.02	1	790.00	254.71	3
	Hardness mg/L	120			120			147			189			209			232		

Sampling Timeline	Metals (ug/L)	DR-26			DR-6-SW			DR-9-SW			DR-27			DR-7-SW			DR-4-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	nd	hard nd	uk	1.11	4.62	0	0.97	4.71	0	13.70	6.22	2	1.41	6.22	0	0.42	2.99	0
	Chromium (t)	nd	hard nd	uk	u	165.66	uk	u	169.21	uk	u	230.67	uk	u	230.67	uk	u	102.18	uk
	Copper (d)	nd	hard nd	uk	1.70	33.84	0	3.85	34.67	0	84.60	49.52	2	8.55	49.52	0	3.85	19.41	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	nd	1000.00	uk	43.40	1000.00	0	317.00	1000.00	0	251.00	1000.00	0	1240.00	1000.00	1	224.00	1000.00	0
	Lead (d)	nd	hard nd	uk	0.49	7.20	0	0.10	7.39	0	0.38	10.94	0	3.17	10.94	0	0.21	3.85	0
	Manganese (d)	nd	hard nd	uk	30	2288	0	315	2308	0	874	2618	0	789	2618	0	114	1880	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	nd	hard nd	uk	nd	119.37	uk	18.60	122.01	0	nd	168.04	uk	nd	168.04	uk	nd	72.46	uk
	Selenium (d)	nd	4.60	uk	1.07	4.60	0	0.87	4.60	0	u	4.60	uk	1.59	4.60	0	0.99	4.60	0
	Silver (d)	nd	hard nd	uk	u	1.73	uk	u	1.81	uk	u	3.47	uk	u	3.47	uk	u	0.63	uk
	Zinc (d)	nd	hard nd	uk	235.00	287.13	1	317.00	293.53	1	3630.00	405.26	9	464.00	405.26	1	110.00	173.63	1
	Hardness mg/L	nd			267			274			946			777			148		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	nd	hard nd	uk	nd	hard nd	uk	0.40	5.10	0	1.70	6.22	0	0.40	6.22	0	0.90	3.94	0
	Chromium (t)	nd	hard nd	uk	nd	hard nd	uk	0.20	184.74	0	u	230.67	uk	u	230.67	uk	0.20	138.73	0
	Copper (d)	nd	hard nd	uk	nd	hard nd	uk	0.90	38.35	0	10.30	49.52	0	1.30	49.52	0	1.10	27.59	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	nd	1000.00	uk	nd	1000.00	uk	650.00	1000.00	1	30.00	1000.00	0	10300.00	1000.00	10	280.00	1000.00	0
	Lead (d)	nd	hard nd	uk	nd	hard nd	uk	u	8.27	uk	u	10.94	uk	u	10.94	uk	u	5.73	uk
	Manganese (d)	nd	hard nd	uk	nd	hard nd	uk	2450	2392	1	175	2618	0	1580	2618	1	289	2129	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	u	0.01	uk	0.0005	0.01	0
	Nickel (d)	nd	hard nd	uk	nd	hard nd	uk	u	133.59	uk	nd	168.04	uk	nd	168.04	uk	nd	99.38	uk
	Selenium (d)	nd	4.60	uk	nd	4.60	uk	1.00	4.60	0	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	nd	hard nd	uk	nd	hard nd	uk	u	2.18	uk	u	3.47	uk	u	3.47	uk	u	1.19	uk
	Zinc (d)	nd	hard nd	uk	nd	hard nd	uk	100.00	321.62	0	1850.00	405.26	5	650.00	405.26	2	200.00	238.71	1
	Hardness mg/L	nd			nd			305			968			993			215		

Std. - water quality standard

HQ - hazard quotient

u - undetected

nd - no existing data for the analyte at this site during this sampling event

hard nd - no standard calculated because standard is dependent on hardness detection which is nd

HQ 2-10 indicates an uncertain potential for risk

uk - unknown HQ value

Table 4.23 Dolores River, Silver Creek, and St. Louis Ponds Copper- Zinc Indicies (CZI).

Site		July 2002			Oct 2002			Oct - Dec 2003			April 2004			Dec 2004		
		Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI
Dolores River	DR-1	u	20.00	uk	u	u	uk	0.80	10.00	0	u	8.95	uk	u	u	uk
	DR-20	u	20.00	uk	u	u	uk	na	na	uk	na	na	uk	u	u	uk
	DR-2	2.00	20.00	0	u	u	uk	1.60	u	uk	4.60	na	uk	u	u	uk
	DR-7	1.00	20.00	0	u	u	uk	2.00	40.00	0	u	29.20	uk	1.40	170.00	0
	DR-2-SW	2.00	50.00	0	u	40.00	uk	2.40	130.00	0	3.60	20.00	0	1.00	180.00	0
	DR-1-SW	3.00	580.00	2	u	850.00	uk	3.30	1230.00	3	7.70	1570.00	4	1.10	790.00	2
	DR-26	1.00	80.00	0	u	60.00	uk	0.60	0.20	0	na	na	uk	na	na	uk
	DR-6-SW	na	na	na	na	na	uk	na	na	uk	1.70	235.00	1	na	na	uk
	DR-9-SW	2.00	40.00	0	u	30.00	uk	2.20	70.00	0	3.85	317.00	1	0.90	100.00	0
	DR-27	10.00	920.00	3	u	690.00	uk	18.30	1830.00	5	84.60	3630.00	11	10.30	1850.00	5
	DR-7-SW	2.00	880.00	2	u	760.00	uk	4.60	840.00	2	8.55	464.00	1	1.30	650.00	2
	DR-4-SW	1.00	10.00	0	u	50.00	uk	2.60	110.00	0	3.85	110.00	0	1.10	200.00	1
Silver Creek	SVS-1T	na	na	uk	na	na	uk	0.60	u	uk	nd	nd	uk	u	u	uk
	SVS-1	na	na	uk	na	na	uk	0.80	30.00	0	2.95	18.40	0	u	u	uk
	SVS-22	2.00	420.00	1	u	290.00	uk	3.10	640.00	2	7.10	424.00	1	0.70	450.00	1
	SVS-12	2.00	6110.00	15	u	5070.00	uk	6.10	nd	uk	4.70	6140.00	15	2.60	5910.00	15
	SVS-8	2.00	940.00	2	u	490.00	uk	3.00	nd	uk	5.15	433.00	1	1.00	570.00	1
	SVS-26	51.00	8050.00	21	70.00	8120.00	22	187.00	6530.00	21	509.00	5610.00	27	53.90	7110.00	19
	SVS-20	2.00	470.00	1	u	390.00	uk	2.60	560.00	1	7.10	565.00	2	1.30	730.00	2
St. Louis Ponds	DR-3	20.00	3430.00	9	30.00	2970.00	8	20.60	5190.00	13	27.30	4180.00	11	18.50	4200.00	11
	DR-6	3.00	410.00	1	u	400.00	uk	6.40	1120.00	3	9.50	1690.00	4	7.60	3140.00	8

CZI - Copper-Zinc Index
>1 CZI - indicator of requiring further evaluation
uk - unknown
na - not analyzed
u - undetected

Table 4.24. Temporal Change in Load as Observed for 1997, 2002, 2003 and 2004.

Metal	Year	Calculated lb/cfs by Location		Change in lbs between Locations (DR-4-SW – DR-2-SW)
		DR-2-SW	DR-4-SW	
Iron	1997	13.6/70 = 0.19	28.96/57.7 = 0.50	+ 0.31
	2002	43.59/35.12 = 1.24	36.13/35.23 = 1.02	-
	2003	9.89/15.27 = 0.65	15.64/17.05 = 0.92	+ 0.27
	2004	23.79/29.39 = 0.81	55.31/36.6 = 1.51	+ 0.30
Manganese	1997	64.98/70 = 0.92	75.36/57.7 = 1.31	+ 0.39
	2002	24.64/35.12 = 0.7	27.19/35.23 = 0.77	+ 0.07
	2003	22.75/15.27 = 1.48	29.17/17.05 = 1.71	+ 0.23
	2004	37.27/29.39 = 1.27	57.09/36.6 = 1.56	+ 0.29
Zinc	1997	40.05/70 = 0.57	51.69/57.7 = 0.89	+ 0.32
	2002	7.58/35.12 = 0.22	9.51/35.23 = 0.27	+ 0.05
	2003	10.71/15.27 = 0.70	10.21/17.05 = 0.59	+ 0.29
	2004	28.55/29.39 = 0.97	39.51/36.6 = 1.07	+ 0.10

Table 4.25 Summary of Flow Loss Observed for the St. Louis Settling Ponds.				
Year	Sampling Event	DR-3 (St. Louis Tunnel)	DR-6 (Settling pond outfall)	Flow Loss (cfs and % of total)
2002	July	Not available	Not available	Unknown
	October	1.03	0.15	0.88 (85%)
2003	October – December	0.73	0.30	0.43 (59%)
2004	April	1.37	0.46	0.91 (66%)
	December	1.41	0.87	0.54 (38%)

Table 4.26 Summary of Zinc Load Loss Observed for the St. Louis Settling Ponds.				
Year	Sampling Event	DR-3 (St. Louis Tunnel)	DR-6 (Settling pond outfall)	Flow Loss (cfs and % of total)
2002	July	Not available	Not available	Unknown
	October	1.03	0.15	0.88 (85%)
2003	October – December	0.73	0.30	0.43 (59%)
2004	April	31	4.2	26.8 (86%)
	December	32	15	17 (53%)

FIGURES

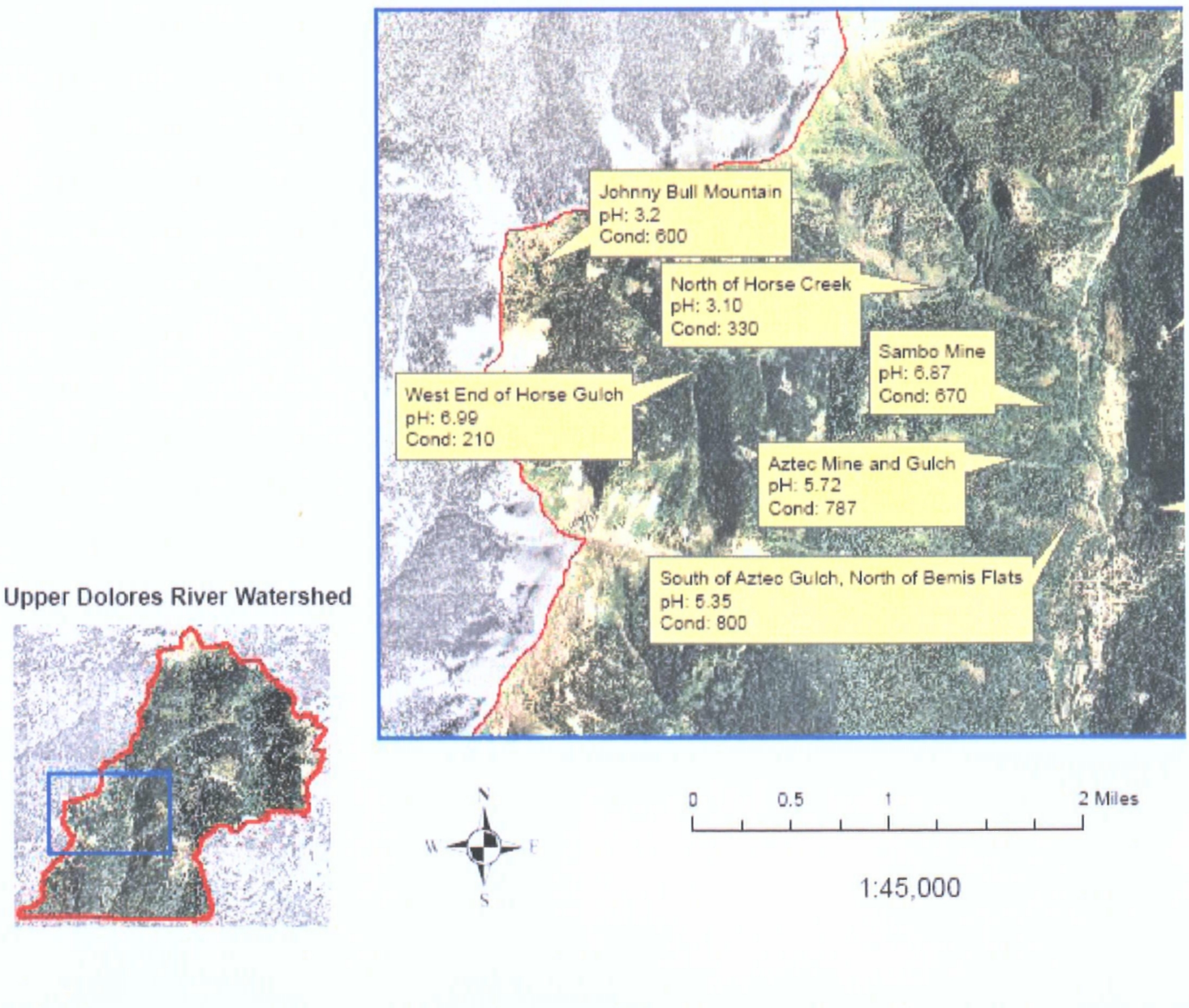
Figure 4.1. Timeline of Water Quality Studies Completed within the Project Area.

	Timeline	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Soils	EPA (1986)								X				
	Walsh(2003)											X	
	ARCO VCUP (1994-present)												
	Titan (1996)										X		
	ARCO/CDPHE (1996)										X		
	CDPHE/Brownsfield (2003)											X	
Sediment	EPA (1984, 1986)							X	X				
	K. Paser (1996)										X		
Surface Water Quantity/Quality	USGS, flow (1954-present)												
	EPA (1984)							X					
	K. Paser (1996)										X		
	SEH (1996-present)												
	CDPHE (2001)											X	
Groundwater	EPA (2003)											X	
	Walsh (2003)											X	

Figure 4.1. Timeline of Water Quality Studies Completed within the Project Area.

	Timeline	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Soils	EPA (1986)								X				
	Walsh(2003)											X	
	ARCO VCUP (1994-present)									→	→	→	→
	Titan (1996)										X		
	ARCO/CDPHE (1996)										X		
	CDPHE/Brownsfield (2003)											X	
Sediment	EPA (1984, 1986)							X	X				
	K. Paser (1996)										X		
Surface Water Quantity/Quality	USGS, flow (1954-present)	→	→	→	→	→	→	→	→	→	→	→	→
	EPA (1984)							X					
	K. Paser (1996)										X		
	SEH (1996-present)										→	→	→
	CDPHE (2001)											X	
Groundwater	EPA (2003)											X	
	Walsh (2003)											X	

Figure 4.2. CGS AML Site Locations within the Project Area.



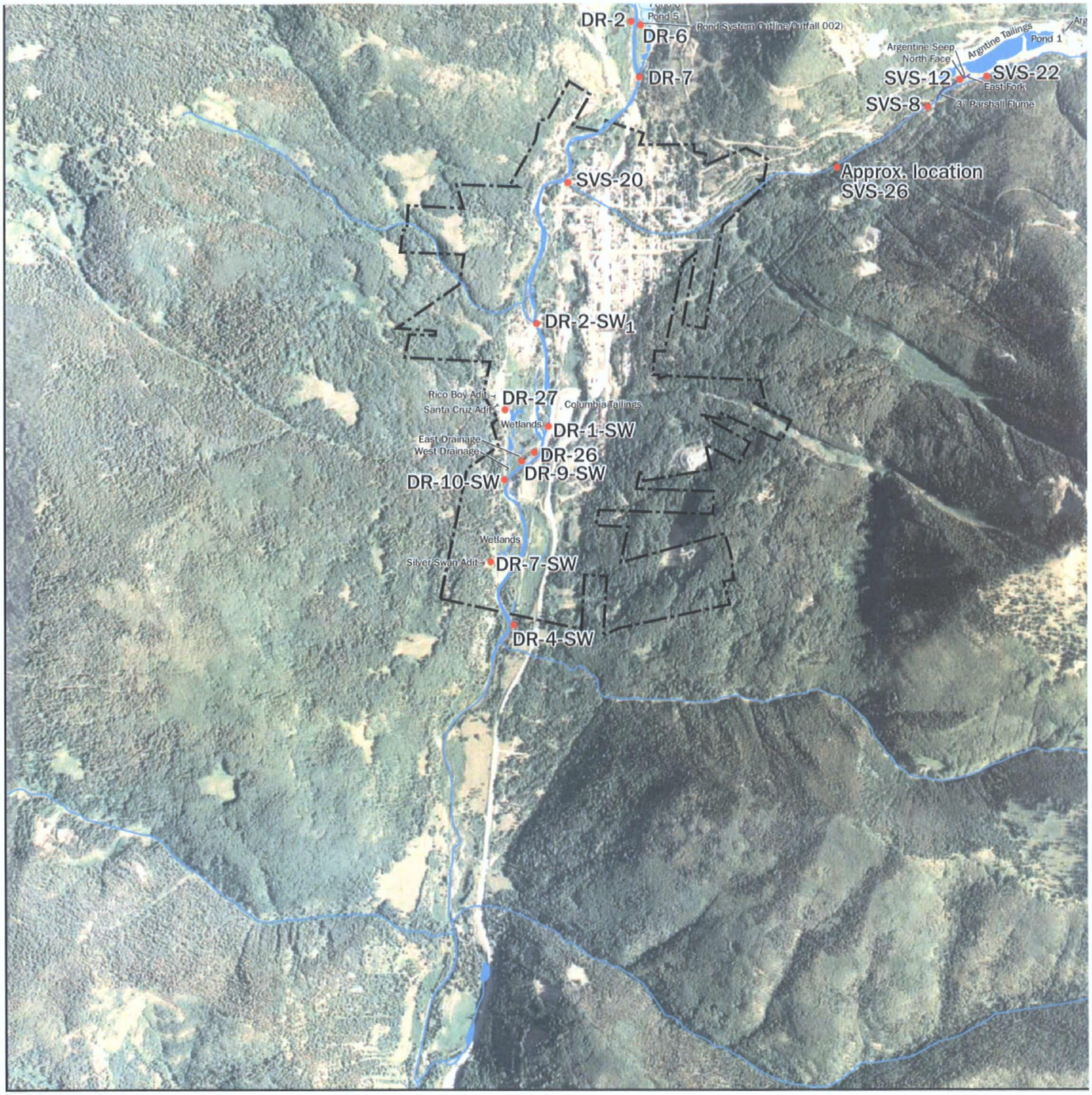


Figure 4.3

SEH Sampling Locations

LEGEND

—·—	Rico Municipal Boundary	• **DR-4-SW**	SEH Sampling Locations
——	Rivers & Streams	Silver Swan Adit	Adits
	Water Impoundment		

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Aquatic Toxicologist

Figure 4.4. USEPA STORET Sam Locations.

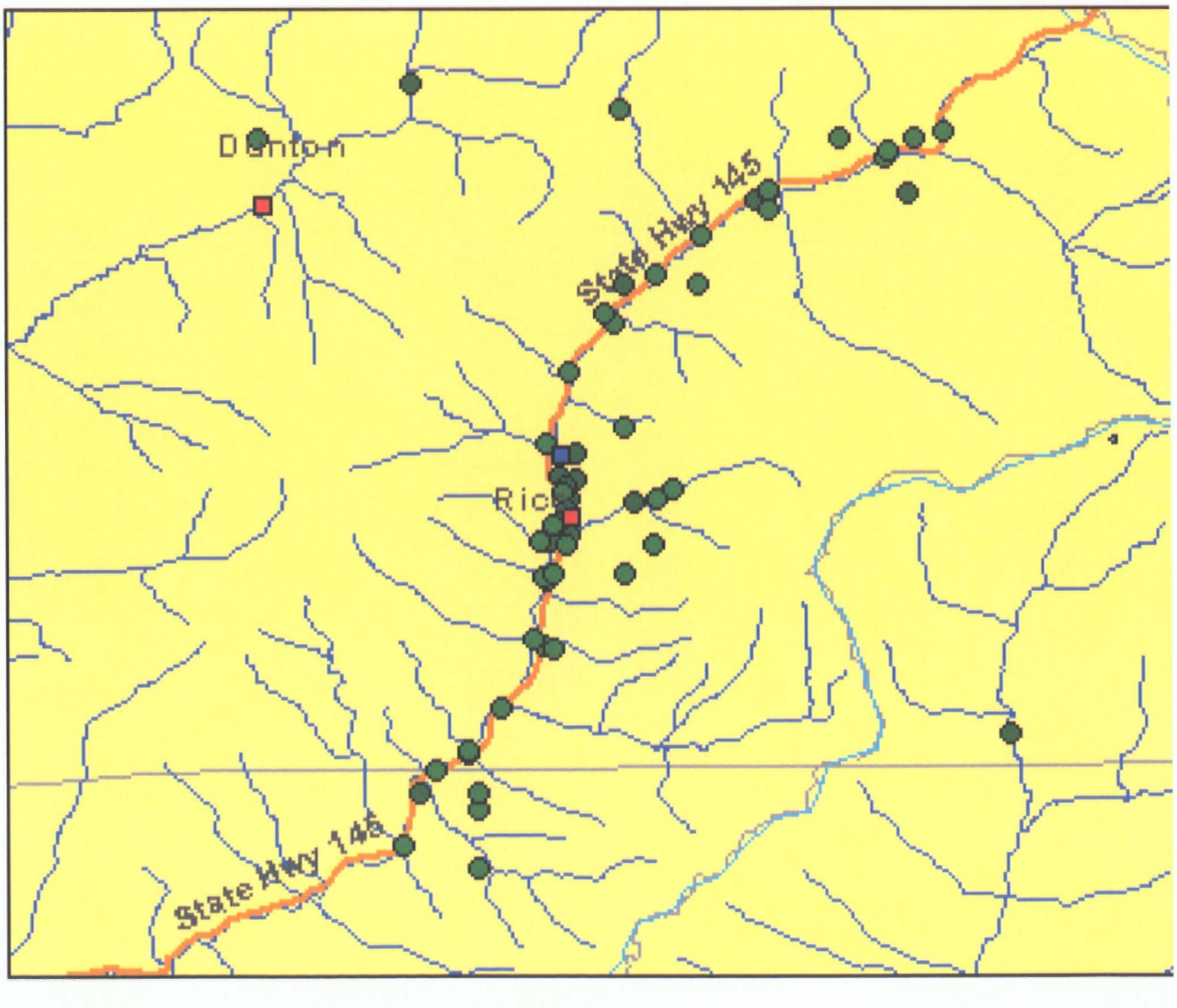

Figure 4.5. CDPHE Sampling Locations.

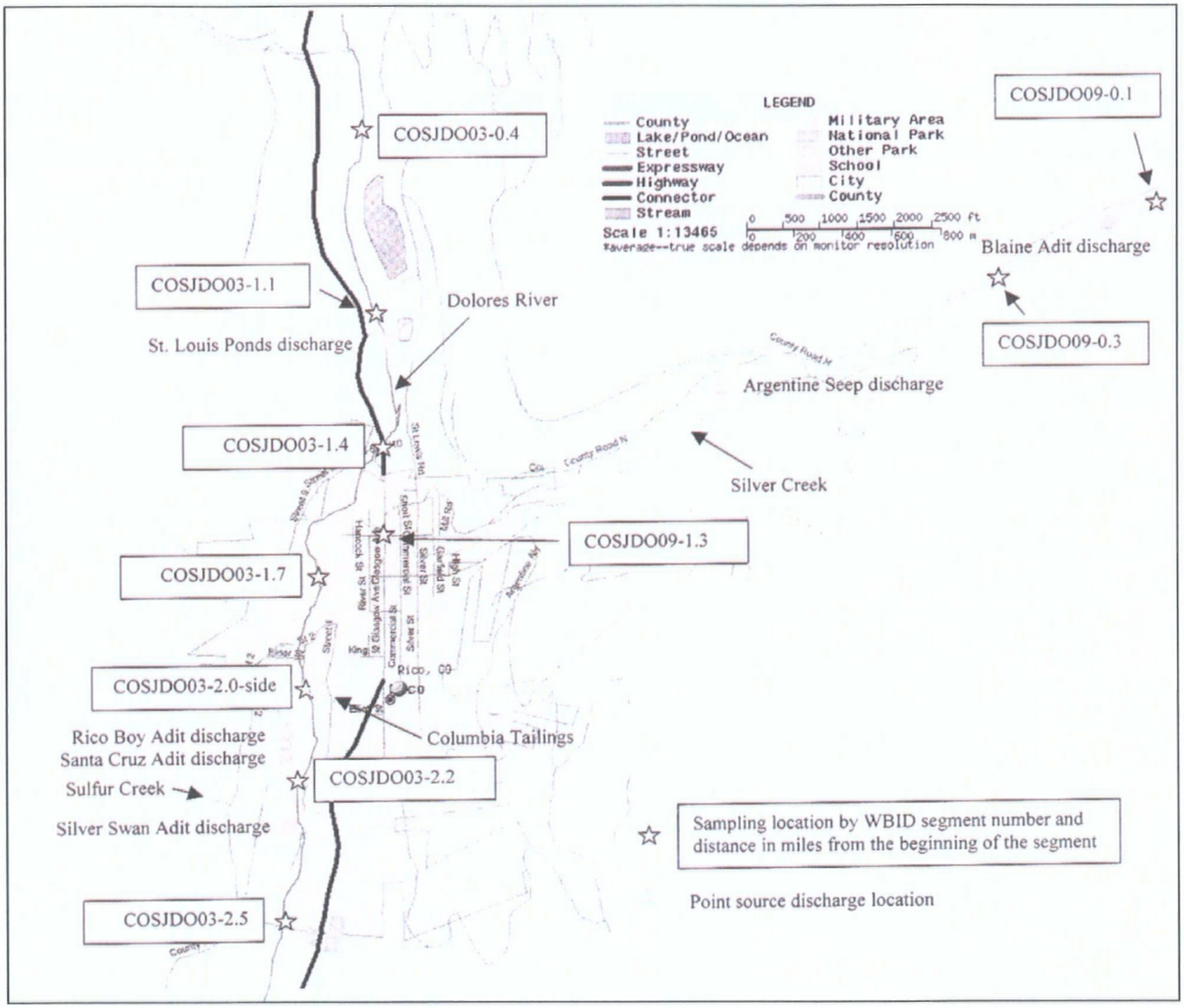

Figure 4.6. CDOW Riverwatch Sampling Locations.

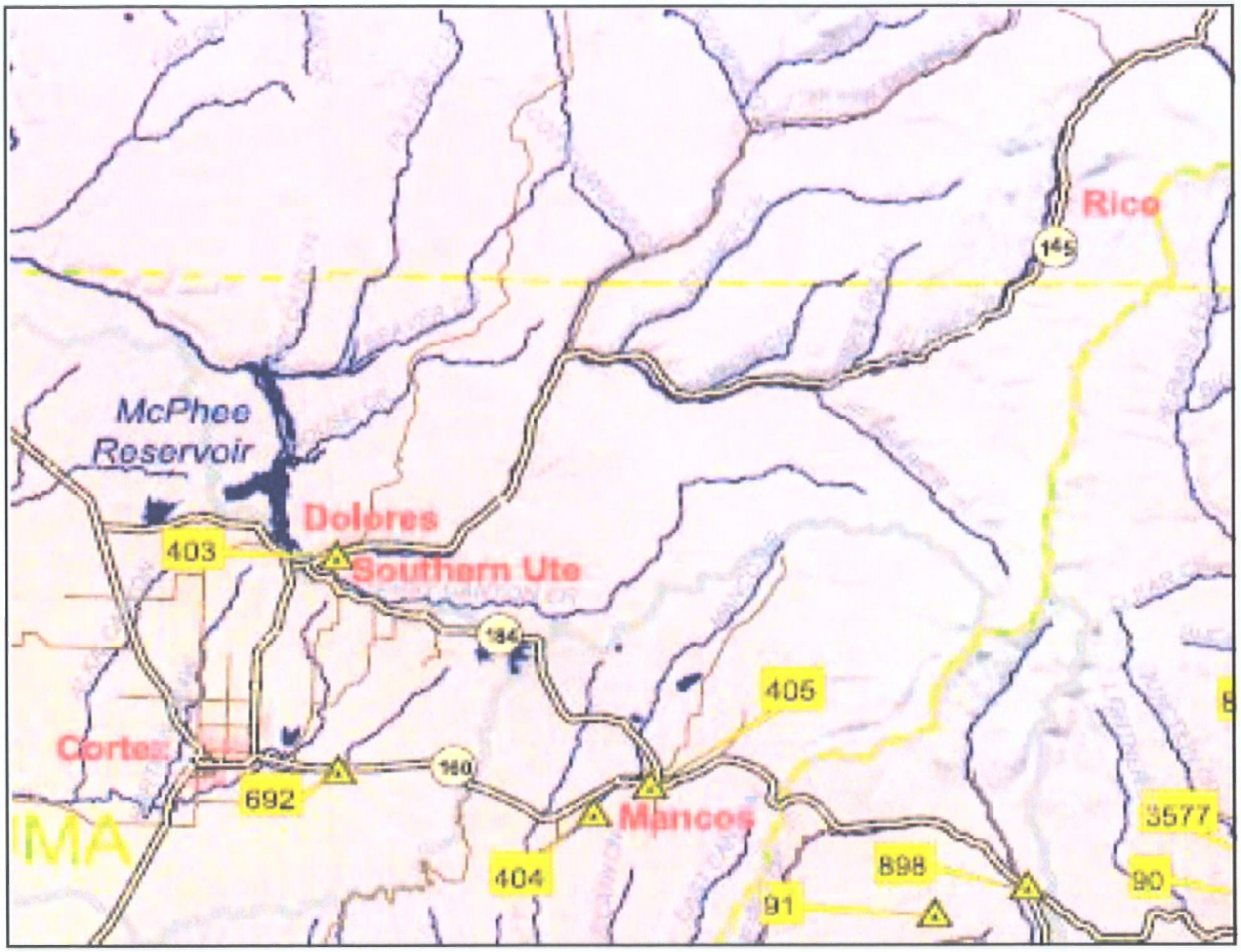

Figure 4.7. July 18-19, 2002. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.

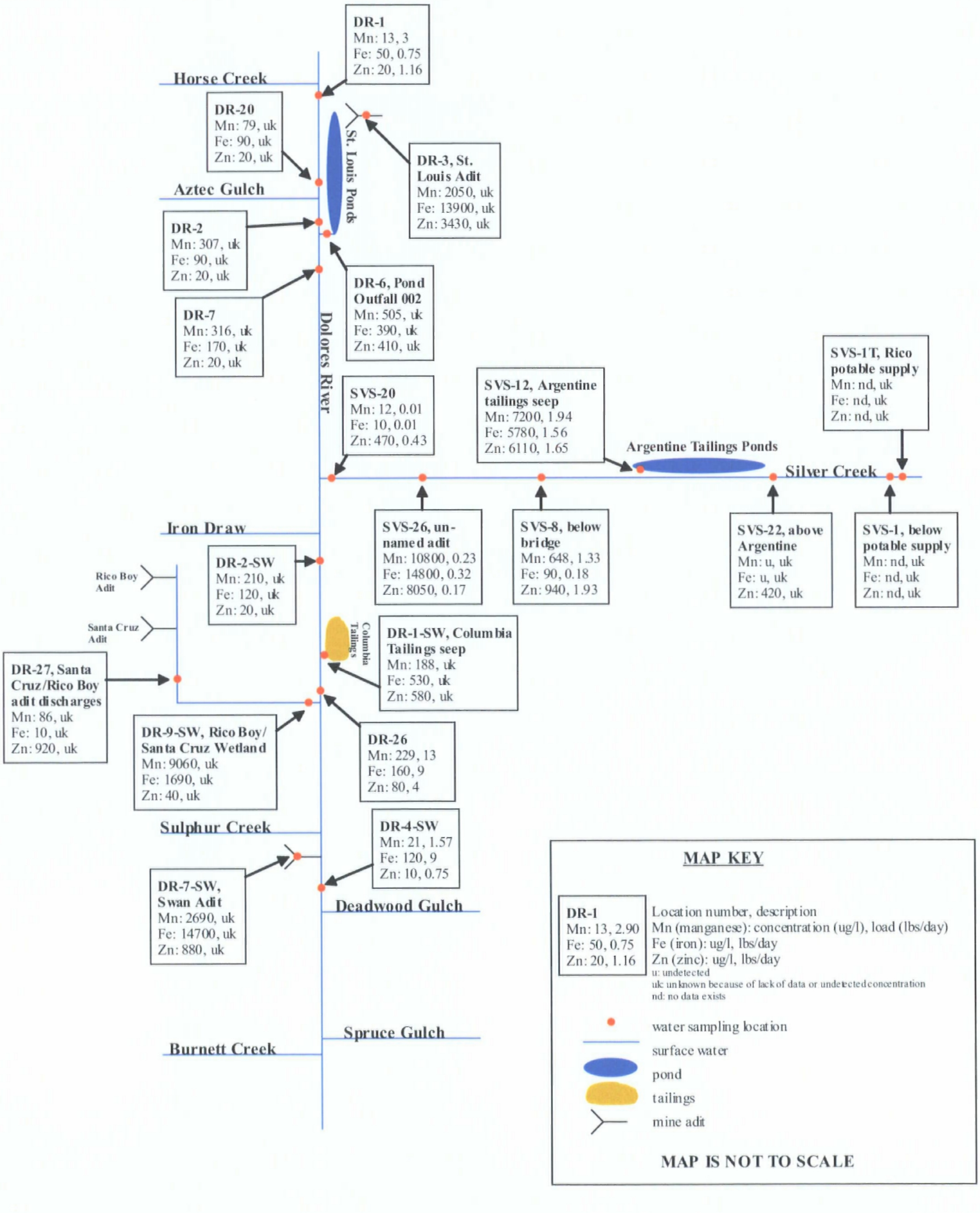

Figure 4.8. October 6-9, 2002. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.